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A TAXONOMIC REVISION OF SAGINA (CARYOPHYLLACEAE) IN NORTH AMERICA[1]

GARRETT E. CROW

Sagina (Pearlwort), a genus of the Caryophyllaceae, consists of about 15 species indigenous to the cool temperature regions of the Northern Hemisphere. The genus is well defined, although it is occasionally confused with superficially similar taxa of *Spergularia* and *Arenaria*. Confusion with taxa of *Colobanthus*, the genus most closely related to *Sagina* (Pax & Hoffman, 1934), seldom occurs because *Colobanthus* is a circumaustral genus.

There has been, however, confusion within the genus regarding delineation of taxa. Wright (1935, p. 1) commented "I find among my friends many who are unwilling to give a definite opinion on Saginas, regarding them difficult to determine. I think such opinion arises from inadequate realisation of the extreme variability of these plants." The extreme variability within the genus has generated nomenclatural recognition of numerous variants, especially in Europe, the primary center of diversity for the genus. Many of these taxa were based on characters which are inconsistent in expression.

Previous work of a revisionary nature in *Sagina* is limited. Works include only a revision of the British species of *Sagina* by Williams (1918) and a treatment of the species of *Sagina* occurring in Japan by Mizushima (1960).

My study was undertaken with the intention of assessing the variability within the genus and attempting to clarify interspecific and intraspecific relationships. Over 6000 herbarium specimens, European and east Asian as well as North American, were ex-

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amined. Most of the North American taxa have also been studied in the field and in a growth chamber. An analysis of the seed morphology, utilizing scanning electron microscopy, has been helpful in assessing relationships within the genus.

This revision is presented to provide a better understanding of the species in North America, to contribute to the knowledge of the entire genus and to benefit resolution of problems in the classification of other genera of the subfamily Alsinoideae.

HISTORICAL ACCOUNT

Botanical history of *Sagina* begins in the 17th Century with the finding of *S. nodosa* by John Goodyer on August 12, 1626, "on the boggy ground below the red Well of Wellingborough in Northamptonshire" in Great Britain, recorded in Johnston's Herball in 1633 under the name "Saxifraga palustris alsine folia" (Williams, 1918; Druce, 1932). In 1719 Dillenius included the Pearlworts under the generic name *Alsinella* in his *Catalogus Plantus*, a pre-Linnean name perpetuated by Hill (1756) in *The British Herbal* and by Greene (1891) in *Flora Franciscana*.

The generic name *Sagina* first appears in print in Linnaeus' *Systema Naturae* in 1735. His *Genera Plantarum* (1737b) indicates it was based on *S. procumbens*. In *Species Plantarum* (Linnaeus, 1753) the genus included two tetramerous members of the tribe Alsineae, *Sagina procumbens* and *Moenchia erecta*, and a third species, *Bartonia virginica*, now recognized as belonging to the Gentianaceae.

Presl (1826), in his *Flora Sicula*, was the first to include any of the exstipulate Spergulas in the genus *Sagina*. Dumortier (1827), on the other hand, recognized the non-stipulate Spergulas of Linnaeus as a distinct genus, *Phaloe*. Reichenbach (1827) likewise regarded this group as a separate genus, giving it the name *Spergella*. Fenzl's (1833) redefinition of *Sagina* retained only *S. procumbens* of Linnaeus' genus and incorporated Reichenbach's *Spergella*. Koch (1837), in the first edition of *Synopsis Florae Germanicae et Helveticae* retained Reichenbach's *Spergella* in the genus *Spergula* as sect. *Spergella*. In the second edition (Koch, 1843) he transferred sect. *Spergella* to *Sagina*, thus erecting the subdivisions in *Sagina* as sect. *Saginella*, including the 4-merous taxa, and sect. *Spergella*, comprising the 5-merous taxa.

Although this subdivision is sometimes followed in European floristic works, it neither adequately reflects natural relationships, nor provides a practical basis for classification. Not only are there both 4- and 5-merous plants within taxa, but individual plants may have both types of flowers.

Moss (1920), in his treatment of *Sagina* for the *Cambridge British Flora* regarded the species as being too closely allied to be meaningfully subdivided into distinct groups higher than series. Thus, he treated the British Saginas in four series: *Nodosae, Subulatae, Procumbentes,* and *Apetalae.* With the exception of ser. *Apetalae* his groupings are quite natural. However, they deal only with the British species.

Mizushima (1960) likewise concluded that generic subdivision does not merit rank above series level and attempted to apply Moss' series to the east Asian Saginas, but found it necessary to redefine these series. Unfortunately he based these divisions on 4-merous taxa versus 5-merous taxa.

Recently, Löve and Löve (1975) have expressed the viewpoint that *Sagina,* at the generic level, is heterogeneous, and they support recognition of three genera on cytological grounds: *Sagina* L., characterized by a basic chromosome number $x = 11$; *Saginella* Koch (never published at the generic level) with a basic number of $x = 6$; and *Spergella* Reichb., with a basic number of $x = 7$. Unfortunately both taxa which the Löves transferred to *Spergella* (*Sagina caespitosa* and *S. intermedia*) have a basic number of $x = 11$ (not $x = 7$). In my opinion neither cytological nor morphological evidence suggests that *Sagina* should be divided at the generic level.

FLORAL MORPHOLOGY

Inflorescence. The flowers of *Sagina* are borne singly and are terminal and axillary in position. Vivian (1942) has shown in an investigation of phyllotaxy in *S. procumbens* that this apparent floral arrangement is, in actuality, a modification of the typical caryophyllaceous cymose inflorescence, a uniparous scorpioid cyme.

Flowers. The flowers are quite small and generally inconspicuous. Both pentamerous and tetramerous flowers occur. Gynodioecy has been observed in some European populations of *Sagina procumbens, S. saginoides, S. nodosa* and *S. nivalis* (Müller, 1883); however, this state has not been observed in the North American plants.

Figure 1. *Sagina nodosa*. Flower showing nectariferous gland at the base of outer whorl of stamens (opposite sepals).

Glandular hairs occur associated with the flowers in several taxa. Most densely concentrated at the calyx base and uppermost portion of the pedicel, the hairs are uniseriate, arising from the epidermis and consisting of three or four cells with a knobbed glar at the apex (Figure 2).

Calyx. The sepals are separate to the base and elliptical to orbicular and blunt at the apex. Rarely are the sepals acute and this is never characteristic of a taxon. A narrow band of hyaline tissue occurs around the margins of the sepals and is generally whitish. When anthocyanins are abundant in the sepals the whole sepal may take on a purplish cast. More frequently, color is concentrated in the hyaline margin or sometimes only the tip takes on the distinctive purplish tinge. In bud the sepals are imbricate, cupped and frequently cucullate. Sepal size does not increase during capsular maturation.

Corolla. Occasionally emarginate, the petals alternate with the sepals, are thin, white, elliptical to orbicular in shape, have a short

claw at the base and are typically blunt at the tip. Development occurs late in the bud stage, and in some taxa the petals remain poorly developed, vestigial, or aborted. In the annual taxa the petals are frequently caducous. In taxa where the petals are shorter than, equal to, or slightly exceeding the sepals, there is very little shrinkage and no withering. Petals which conspicuously exceed the sepals wither considerably following anthesis.

Androecium. The stamens occur in one or two whorls and are the same number as or twice that of the styles. Stamens of the outer whorl, opposite the sepals, are nectariferous at the base (Figure 1). In cases where there is one whorl, it is the outer, nectariferous whorl which is present. Meiosis and pollen grain maturation take place very early in the bud stage, long before stamens take on a mature form. Anther dehiscence is longitudinal and extrorse. Individual cases of aborted stamens are not uncommon in the genus. Anther dehiscence more frequently occurs prior to floral anthesis and stamens are only very slightly exserted beyond the calyx and never exceed the stigmas. Filaments ultimately bend toward the stigmas, effecting self-pollination.

The pollen grains (Figure 3) are spherical, range between 18 μ and 36 μ in size (mean = 27.5 μ), and are periporate. The pores have a distinct annulus, are ca. 30 in number, and are evenly distributed. The tectum has indistinct perforations and is distinctly scabrate (terminology from Faegri & Iversen, 1964).

Gynoecium. The ovary is 4- or 5-carpellate with formation of carpel walls arrested early in development, resulting in free-central placentation (Lister, 1884). Ovules are campylotropous. Coherent styles arise from a disc at the apex of the ovary. Elongation occurs just prior to or at anthesis, the styles separating and their inner surfaces becoming papillate and stigmatic. Styles alternate with the sepals and are opposite the sutures of the capsules.

Fruit. The fruit is a capsule with the number of capsule valves equal to that of the styles and sepals. Sutures run from the apex to the base, dehiscence varying from one-fourth the capsule length to the entire length. The capsule remains green until late in the developmental stage and becomes tan or straw-colored upon maturity. According to the fruit classification of Kaden and Kirpicznikov (1965), the fruit type would be termed a cerastiocarpum.

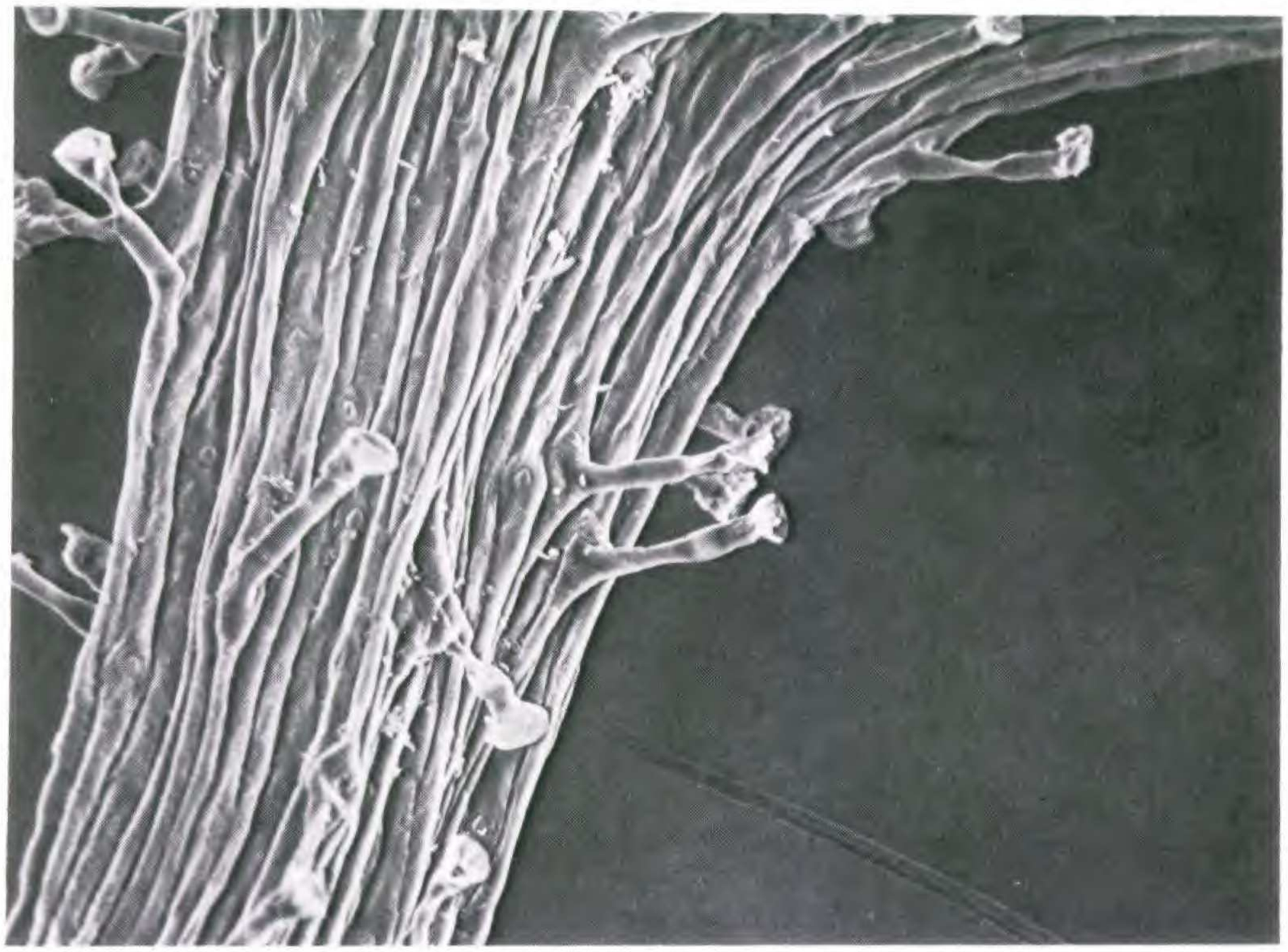

Figure 2. *Sagina nodosa*. SEM micrograph of pedicel showing glandular hairs. × 200.

POLLINATION

The flowers of *Sagina* are all capable of self-fertilization. However, a trend exhibiting a progression from outcrossing to selfing and culminating in cleistogamy can be observed within the genus.

The flowers in *Sagina* open under bright conditions. The stamens of the outer whorl secrete some nectar and insect visitation is thus solicited, though somewhat feebly. Under dull weather conditions the flowers usually remain closed and self-pollination occurs.

There appears to be a strong correlation between petal size and tendency to inbreed, for those plants with the strongest tendency toward selfing and toward cleistogamy are those in which the petals are reduced or lacking.

Sagina nodosa, the strongest outcrosser, is the largest flowered species, with petals being about twice the length of the sepals. The stamens occur in two whorls. The anthers of the outer, nectariferous whorl dehisce at anthesis, while the stigmatic surfaces remain unexposed. Later, the stigmatic surfaces become exposed, receptive and cross-pollination is encouraged. When the sepals close

and push the inner whorl of stamens, with its remaining pollen, onto the stigmas, autogamy results (Wright, 1935).

A further step toward self-fertilization can be seen in *Sagina procumbens*. In this species the androecium is generally reduced to one whorl, the outer, nectariferous whorl. At anthesis the stigmas are receptive and curled toward the stamens. The filaments, in turn, are bent toward the stigmas and the anthers shed their pollen directly onto the stigmas. The nectaries are functional and a few small flies and bees have been reported as visitors (Knuth, 1908). However, the tendency is clearly toward self-pollination, for even in favorable weather the flowers frequently remain closed and effectively pollinate themselves.

In *Sagina apetala,* an annual whose petals are lacking or quickly caducous, pollination takes place quite regularly prior to the flower opening, if, indeed, the flower opens at all.

DISPERSAL

The tiny, light seeds of *Sagina* are well adapted to wind dispersal. Under calm weather conditions dispersal is minimal and seeds remain in the vicinity of the parent plant. In species where dehiscence occurs along the entire length of the sutures, capsule dehiscence is somewhat explosive and seeds are scattered several inches. Raindrops appear to be an effective means of scattering seeds in those species where capsule dehiscence is less than half the length of the capsule. Brodie (1951) has observed this splash-cup dispersal mechanism in *Sagina decumbens* ssp. *decumbens* and has measured dispersal distances up to 18 inches.

Although dispersal is minimal on quiet days, when there is a high degree of air turbulence near the ground light seeds can be lifted to sufficient heights for long distance dispersal to take place (Ridley, 1930; Dahl, 1958; D. Löve, 1963). The seeds of *Sagina* are regarded as prime candidates for long distance dispersal (D. Löve, 1963) and are categorized as "dust diaspores" by Van der Pijl (1969).

PHYTOGEOGRAPHY

Native taxa. The modern distribution patterns of boreal and cool temperate species in North America reflect the effect of Pleistocene glaciation. Thus the postglacial distributions of *Sagina* must be evaluated in this light and an attempt be made to determine where

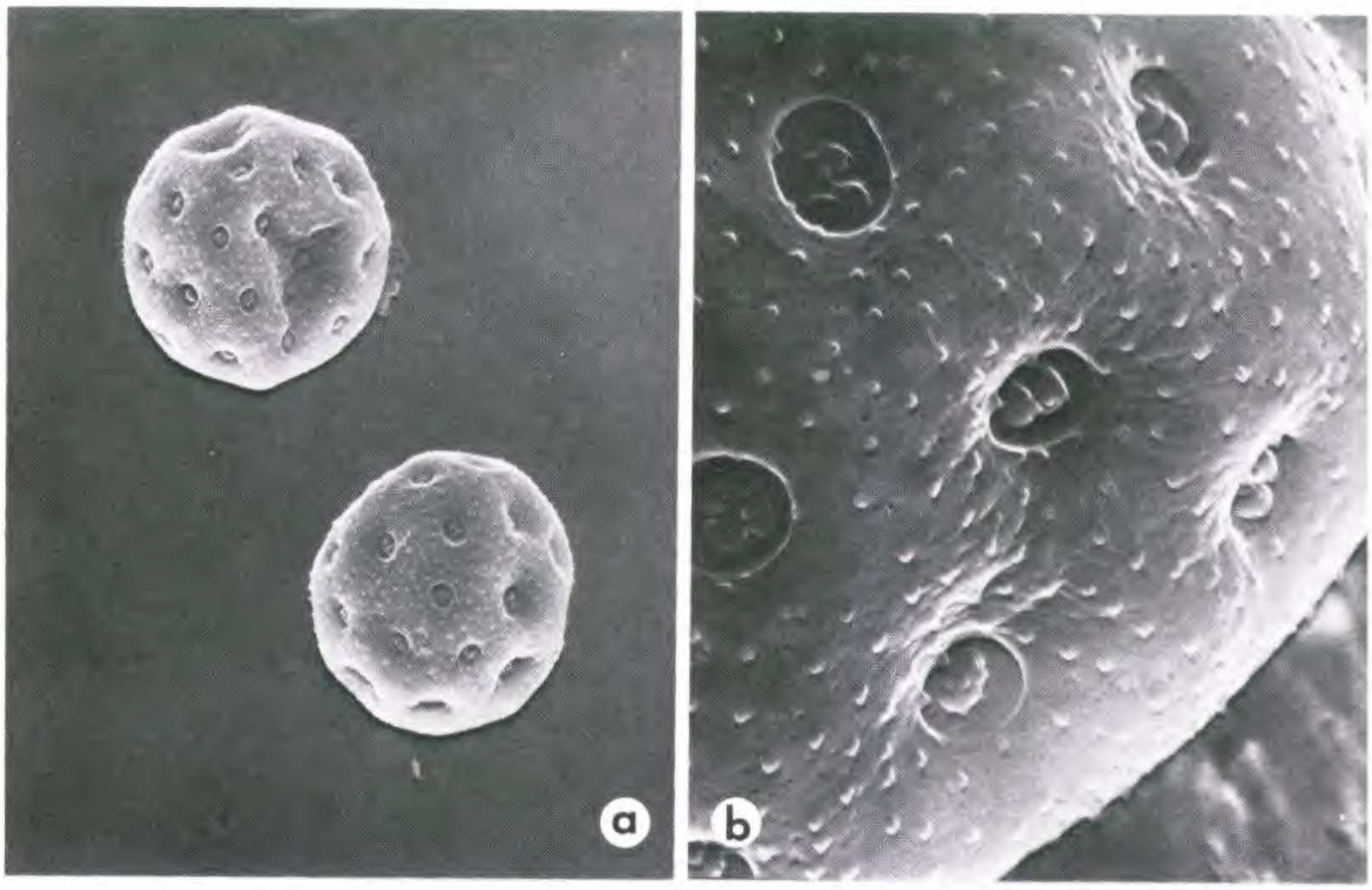

Figure 3. *Sagina nodosa*. Pollen grains, a. × 1000; b. × 5000.

the taxa may have survived the glacial advances.

Circumpolar *Sagina nivalis* is widespread in the North American Arctic and appears to have survived the Pleistocene in the Beringian refugium. A large portion of Alaska, including the Bering Strait region and the North Slope remained ice-free during glacial advances (Péwé *et al.*, 1965; Heusser, 1965) and the geographical distributions of numerous arctic species suggest a "Beringia radiant" pattern (Hultén, 1937).

Although portions of the high Arctic Archipelago do not show signs of glaciation (Flint, 1957; Savile, 1961), this region probably did not serve as a refugium. One would not expect a region like the northwest Elizabeth Islands, with a depauperate flora and stunted plant growth, to function as a survivium (Savile, 1961). Savile is of the opinion that the flora of this region is one recently derived.

Present on Prince Patrick Island and Axel Heiberg Island, but not between, the distribution of *Sagina nivalis* shows a noticeable gap in the region of the northwest Queen Elizabeth Islands. The gap apparently does not reflect lack of collecting, for Savile (1961), who has done much collecting in this region, notes that the distributions of a number of widespread arctic species exhibit this pattern.

Rare disjunct populations of *Sagina nivalis* occur southward in

the alpine habitat along the Cordilleran system to Alberta. It is possible that these populations are relictual. Another possible explanation is that these populations are a result of long distance dispersal having become established in suitable niches in newly opened habitats in the glaciated alpine of the Cordilleran range.

Sagina caespitosa, a rare species, exhibits an amphi-Atlantic distribution, occurring as a coastal plant in the eastern Arctic, western and southern Greenland, and as a montane plant on Iceland and in Scandinavia. The existence of coastal mountain refugia, as described by Dahl (1946), provides the most plausible explanation of survival. Dahl notes that nunataks occurring in western Greenland support a relatively rich flora. The populations occurring in the eastern Arctic of North America have distinct affinity with populations of western Greenland, pubescence of pedicel being present in both, while plants in populations of southern Greenland, Iceland, Jan Mayen and Scandinavia are completely glabrous.

The circumpolar distribution of *Sagina saginoides* correlates almost entirely with montane regions of the Northern Hemisphere. Hultén (1958) notes that the Pleistocene fragmented many circumpolar distributions. This seems to be the case here.

In North America this species survived Pleistocene glaciation in the southern portion of the Cordillera. Although mountain glaciation occurred during the Pleistocene, Weber (1965) points out that large areas in Colorado were free of ice. In the Sierra Nevada, glaciers descended to 1300–2200 meters elevation but numerous refugia existed throughout the range (Wahrhaftig & Birman, 1965). Recession of alpine glaciers in the Olympic Mountains occurred during continental expansion of the Cordilleran ice sheet, thus refugia occurred nearby at the time the Puget Sound lobe reached its maximum (Crandell, 1965).

Mount Albert, on the Gaspé Peninsula of Quebec, has a serpentine summit which supports an alpine flora containing a curious Cordilleran element, including *Sagina saginoides.* Fernald (1925b) considered these disjuncts to be relictual, persisting through the glacial period on this unusual nunatak, but his theory has lost much credibility. Marie-Victorin (1938) does not consider this serpentine habitat as a nunatak, but rather regards it simply as a place where arctic plants can survive while others cannot. The presence of *S. saginoides* at one locality on the eastern shore of Hudson Bay, one locality near Schefferville, Quebec, on the Labrador-Quebec Penin-

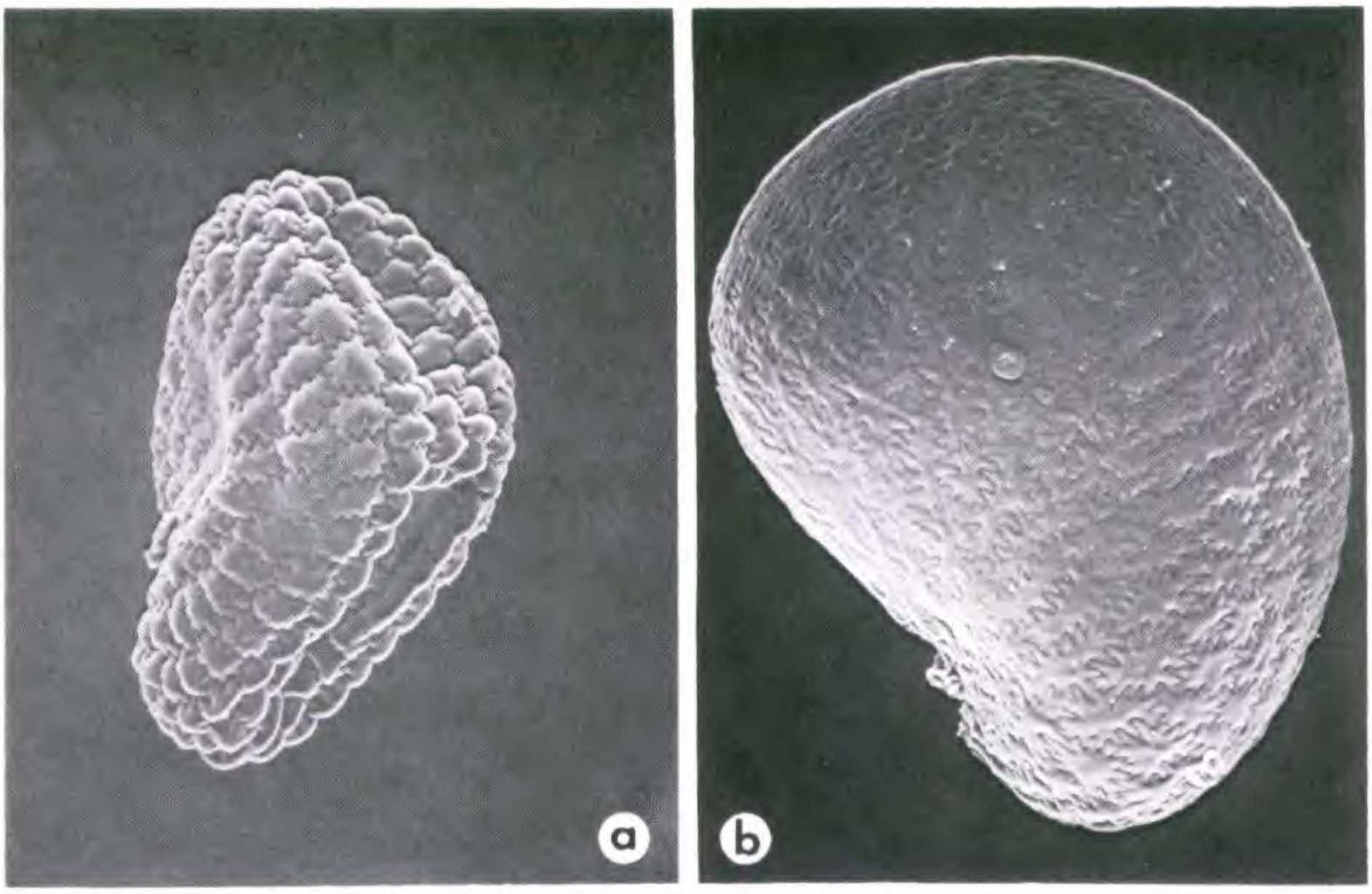

Figure 4. Seed types. a. saginoid seed type, *Sagina apetala*, oblique view showing dorsal groove, × 200; b. crassuloid seed type, *S. maxima* ssp. *crassicaulis*, lateral view, × 200.

sula, and on the Gaspé Peninsula seems better explained as the result of long distance dispersal. The diaspores of the Saginas clearly have properties conducive to long distance dispersal by wind (Löve, D., 1963; Van der Pijl, 1969). These isolated populations illustrate well "a case-in-point" in support of "Baker's Law" regarding long distance dispersal which basically states that for self-compatible taxa a single propagule is sufficient to start a new colony and that establishment is much more likely than establishment of self-incompatible taxa (Baker, 1955, 1967).

Sagina maxima ssp. *crassicaulis*, a strictly coastal taxon, was largely unaffected in the lower and major portion of its range. To the north, however, its range was abruptly truncated by the Cordilleran ice sheet. Hultén (1937) regards the taxon as one of his "Western America Coast Radiants." Migration northward along the coast was likely rapid during the post-Pleistocene as coastal winds may have facilitated rapid dispersal for species with light disseminules (Calder & Savile, 1960; Savile, 1961). Such dispersal would have been enhanced during periods when sea level was lower (Heusser, 1960). Heusser (1960) notes that some diaspores are quite capable of traveling long distances over water, citing as evidence

the composition of the flora of Middleton Island, Alaska. *Sagina maxima* ssp. *crassicaulis* (as *S. crassicaulis*) is recorded in this flora (Thomas, 1957). The range of *S. maxima* ssp. *crassicaulis* reaches northward and westward to Attu Island in the Aleutians.

With the retreat of the ice along the Alaskan coast, the Asiatic *Sagina maxima* ssp. *maxima* was also able to extend its range along the newly opened North American Pacific coast.

While the region south of the glacial boundary provided the major source of plants for the revegetation of western North America, nunataks along the coast of British Columbia and Alaska served as refugia during the Pleistocene. One nunatak complex was the Queen Charlotte Islands, which are noted to have both floristic endemics (Calder & Taylor, 1968) and faunal distinctions reflecting separation from mainland relatives (Heusser, 1960). It is entirely possible that *Sagina maxima* ssp. *maxima* or perhaps even both ssp. *maxima* and ssp. *crassicaulis* could have existed as refugees on this nunatak complex. However, Hultén (1937) considered *Sagina maxima* ssp. *maxima* (as *S. litoralis* Hult.) as a Beringia radiant.

Locating a survivium for *Sagina nodosa* ssp. *borealis* presents a problem, as it occurs entirely within the glacial boundaries of eastern North America. A number of northern species display this distribution pattern, perhaps reflecting a periglacial element (Crow, 1969). Some southward migration of northern species was made possible in part by slightly cooler climatic conditions and in part by lack of competition on the newly exposed coastal terraces and alluvial deposits during withdrawal of the sea (Braun, 1947). *Sagina nodosa* would be well adapted to the periglacial situation, for it is a successful pioneer plant on rocky shores and gravelly beaches. Its capacity for vegetative reproduction through the production of numerous bulbils in the leaf axils increases its effectiveness for rapid migration. Inability to compete well with later successional vegetation might explain its absence from unglaciated regions south of the glacial boundary.

In Europe *Sagina nodosa* ssp. *borealis* is restricted to the northern glaciated regions, apparently having migrated from North America following the retreat of glaciers. Subspecies *nodosa*, having survived the Pleistocene in southern Europe occurs more widely in the southern regions of that continent and where the ranges of the two taxa come together intermediates are not infrequent.

Sagina decumbens ssp. *occidentalis*, a plant of somewhat disturbed habitats at lower elevations of the coastal mountains of the Northwest and of the Great Valley of California, occurs almost entirely within non-glaciated territory and reaches its northern limits at the southern border of British Columbia. The coastal mountains were free from ice, with the exception of a few high peaks in the northern portion (Crandell, 1965; Wahrhaftig & Birman, 1965). In the Great Valley there occurred depositions of large amounts of alluvial soil derived from erosional activity in surrounding mountain systems (Wahrhaftig & Birman, 1965). This disturbance probably provided numerous sites suitable for this taxon.

Hultén (1937) considered the taxon as a "Western America Coast Radiant." However, specimens from his area identified as *Sagina occidentalis* (*S. decumbens* ssp. *occidentalis*) were misdeterminations of plants belonging to the *Sagina maxima* complex.

The present distribution of *Sagina decumbens* ssp. *decumbens* does not readily reflect events of the Pleistocene as its distribution in eastern United States, primarily the Coastal Plain and Piedmont, is within unglaciated territory.

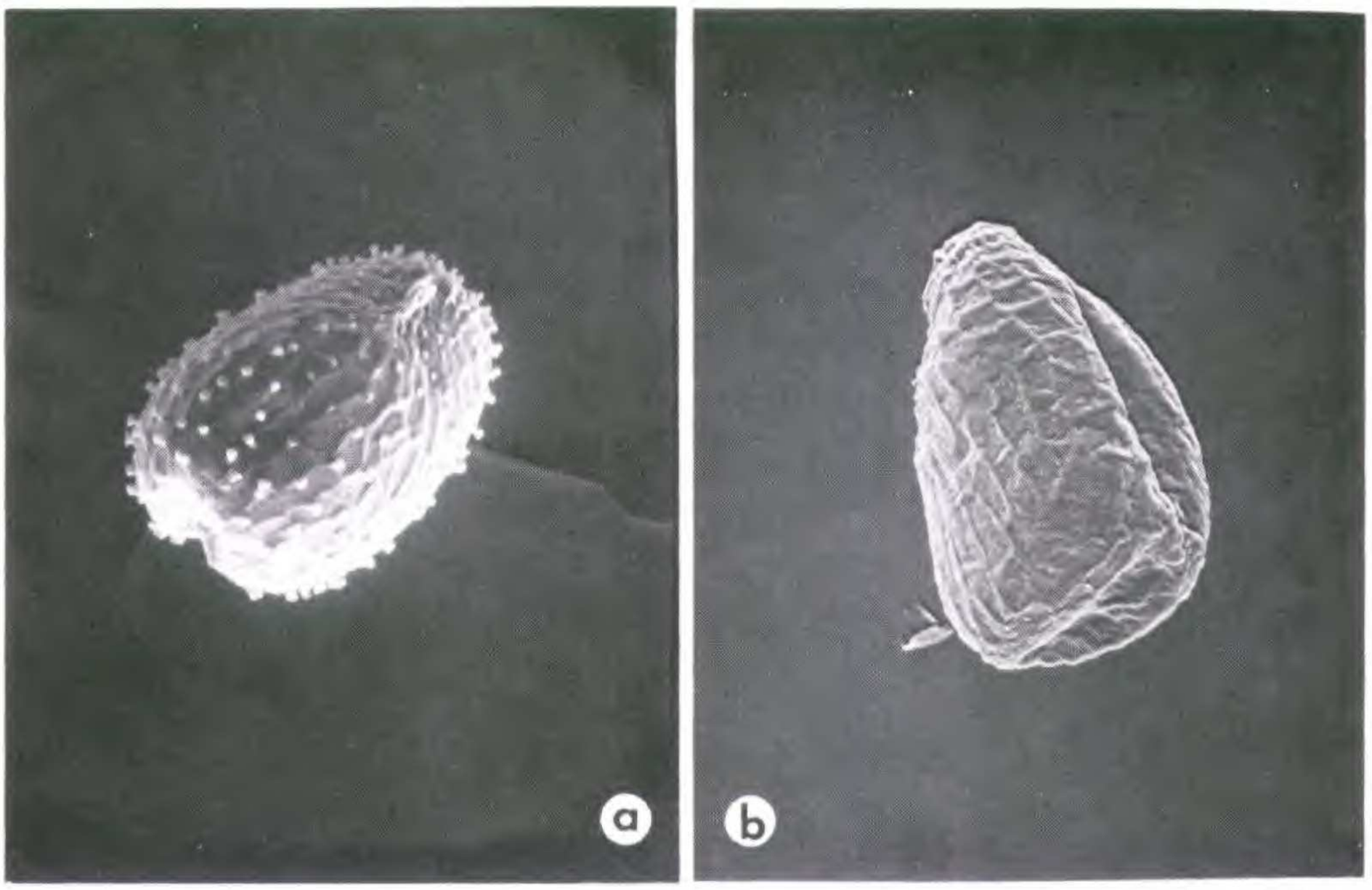

Figure 5. *Sagina decumbens* ssp. *decumbens*. a. seed showing tuberculae borne on ridges, × 200; b. non-tuberculate surface with ridges forming reticulate pattern, × 200.

Introduced taxa. The presence of *Sagina procumbens* in North America as a native of the flora is a matter open to speculation. In the Northeast the plant occurs frequently on coastal rocks and sands and sea cliffs, along stream banks, stream beds and rocks in streams and in springy places. Occurrence in such habitats might lead one to include it as a native species. However, it appears to be equally frequent along roadsides, disturbed ground and around gardens, lawns and dwellings, and in cracks between bricks of sidewalks and pavement.

Torrey and Gray (1838) questioned the status of the species as a native of North America, but subsequently Gray (1895–97), and later Fernald (1950), regarded the species as native. Hultén (1958) includes the species among his "amphi-Atlantic plants," but, in a questioning tone, he notes that the species is anthropochorous to a large extent and attributes a great portion of its Eurasian range and possibly its presence in North America to this type of dispersal. It is noteworthy that in North America the species is most widely established in areas of early settlement, New England and the Maritime Provinces, and is especially prevalent in Massachusetts.

Man is certainly responsible for the species' occurrence in the Southern Hemisphere. Hooker (1847) observed *Sagina procumbens* to be abundant near the sea in the Falkland Islands and considered it most certainly native. However, he also noted that it was indistinguishable from European material. Is it any wonder? Port Louis had been settled in Berkeley Sound by Bougainville in 1763 (Godley, 1965), and ships from Europe regularly visited the island during the 79 years prior to Hooker's visit to this locale. He searched carefully for the plant in Fuegia but did not encounter it. He also indicated he knew no other locality for the plant in the subantarctic region.

Subsequent to Hooker's explorations in Fuegia, an Anglican mission and settlement of Ushuaia was established along the Beagle Channel on Isla Grande, Tierra del Fuego. On an expedition to this region in the austral spring of 1971 I found *Sagina procumbens* to be very abundant in such disturbed sites as roadsides and grassy meadows of logged and burned sites in the *Nothofagus pumilio* forest region; it also appeared very natural growing in a gravelly stream bed at the east end of Lago Fagnano. This latter site is along a gravel highway (the southern extent of the Pan American Highway). In contrast, the plant was not found on the uninhabited

eastern tip of the island, Peninsula Mitre, nor on uninhabited Isla de los Estados, even though "weedy" species native to Fuegia were present (Crow, 1975).

Sagina procumbens has become frequent throughout the sub-antarctic where man has been active. Although the species was not encountered by Hooker on either the Campbell or Kuerguelen Islands, R. C. Harris (personal communication) reports that he found the plant to be frequent at both localities and that growth was so lush in places on Kuerguelen that, on occasion, reindeer (also introduced) feed on it.

Man's activities are most certainly responsible for the occurrence of the species in central and western North America. By the time of the writing of Part 1 of *A Flora of North America* (Torrey & Gray, 1838) *Sagina procumbens* had appeared in the iron mining regions of the south shore of Lake Superior, presumably introduced from eastern North America.

Introduction into the Pacific Northwest probably took place in the latter part of the 1800's. The earliest collections I am aware of include one specimen from Oregon, collected by Elihu Hall in 1871 and one specimen from Vancouver Island, collected by John Macoun, May 9, 1875. As of 1894 the species had apparently not reached San Francisco, where it is now quite common, for it was not included in Greene's *Manual of the Botany of the Region of the San Francisco Bay*.

I am of the opinion that *Sagina procumbens* became introduced into northeastern North America shortly after settlement and soon became naturalized. Introduction into the Northwest most likely came by way of ships sailing around Cape Horn and could have originated from plants from eastern North America or Europe. The early collections in the Northwest are associated with coastal civilization while more recent collections indicate the plant is becoming naturalized in more remote areas of this region.

Sagina apetala is an alien which probably appeared in California during the rapid influx of civilization in the mid-1800's. The earliest recorded specimen I have seen is that of Congdon, collected in April, 1883, in Mariposa Co., California, where the species was probably a well established weed by that time. California collections prior to 1900 include: Mariposa, Tuolumne, Tehama, Plumas, and San Joaquin Counties. As early as 1892 the species had reached southern Jackson Co., Oregon. Greene (1891) described the plant

as a new species (*Alsinella ciliata*) in his *Flora Franciscana.*

Gray (1895–97) indicated the presence of the species in the Middle Atlantic States region, especially near the coast. The specimens he cited, however, belong to *Sagina decumbens* ssp. *decumbens.* I have seen four herbarium specimens from eastern North America referable to *S. apetala.*

Sagina nodosa ssp. *nodosa* appears to have been introduced from Europe prior to the mid-1800's. The earliest collections known were made by J. Blake at Cape Elizabeth, Maine in 1857, and collections prior to 1900 included localities from Massachusetts to Nova Scotia. Several introductions may have occurred, and the taxon appears to be especially well established along the coast in Lincoln Co., Maine and in the region of Digby, Nova Scotia. The taxon is not weedy, and Seymour (1969) notes in *The Flora of New England* that the plant is "uncommon."

The normal range of *Sagina maxima* ssp. *maxima* extends into North America by way of the Aleutian Islands down along the Pacific coast. However, this chiefly northeast Asian taxon also occurs in eastern North America. Here it is of incidental introduction, occurring sporadically and does not appear aggressive or spreading. Known localities include Toronto, Montreal and Quebec, Canada and Amherst, Massachusetts, where plants were found growing in damp places around buildings and along footpaths.

The east Asian *Sagina japonica* has appeared at only three localities, all seaports, in western North America. As early as 1889 Macoun collected the plant at Nanaimo, Vancouver Island. Suksdorf made collections of the species at Portland, Oregon in 1899 and 1900. In 1939 the plant was found growing along a railway bed at Prince Rupert, British Columbia. A single collection, found as a weed in a botanical garden in Ottawa, Ontario, is known from eastern North America.

TAXONOMIC CRITERIA

Taxa within species complexes of *Sagina* native to North America are largely allopatric. While sterility barriers are believed to be poor between taxa, isolation is effective due to habitat preference and/or flowering time, combined with an inbreeding reproductive system. Generic subdivision is based chiefly on seed morphology correlated with floral and vegetative morphology and geographical distribution. Because none of the species can be discriminated by

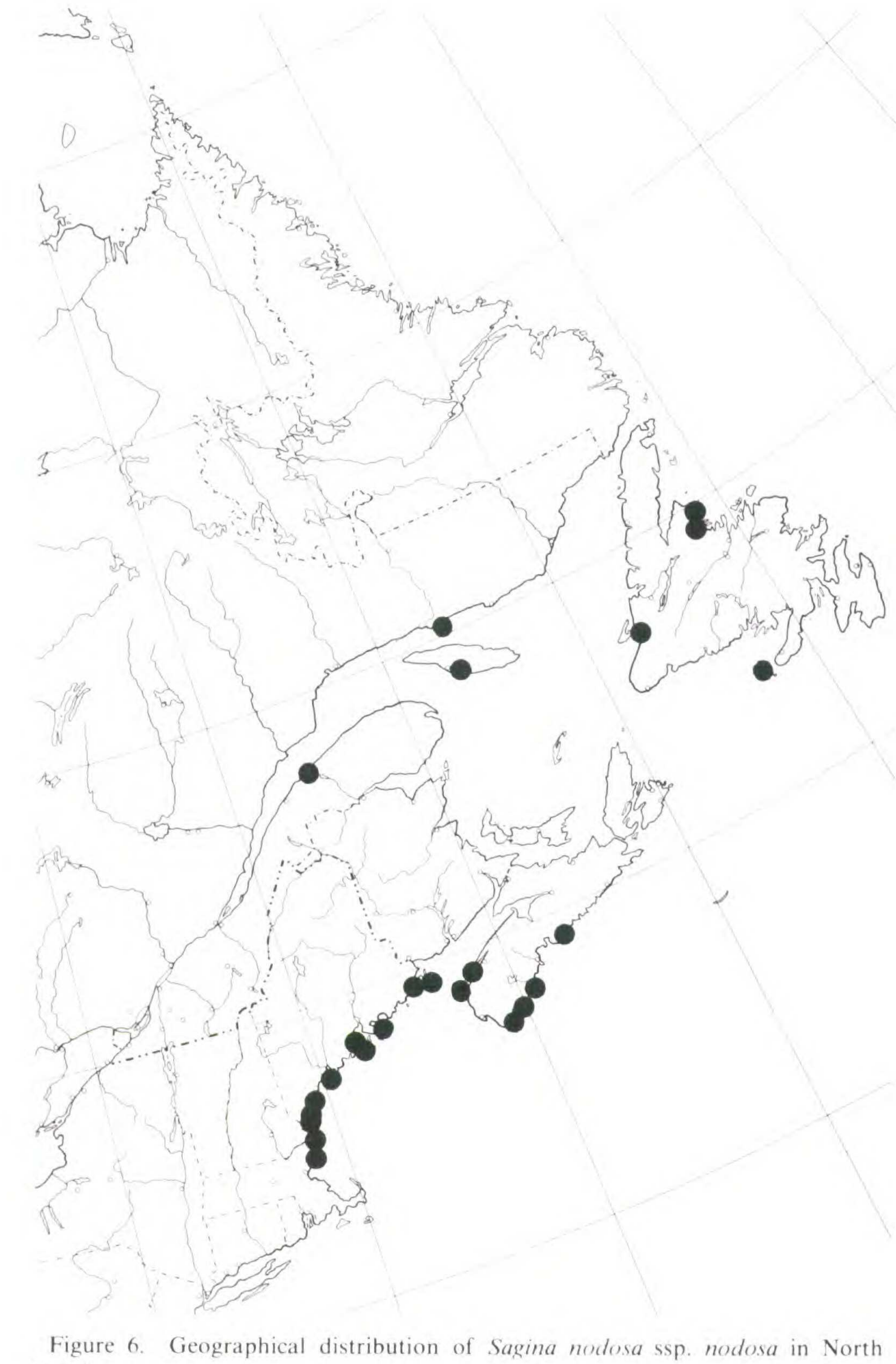

Figure 6. Geographical distribution of *Sagina nodosa* ssp. *nodosa* in North America.

use of any single character, they have been recognized on the basis of combinations of various characters. Taxa reflecting less distinction are treated at the subspecific level. These subspecies are geographically well defined and include considerable morphological variation. Intergradation occurs in regions of geographic overlap. While plasticity in the American taxa is generally too great to permit meaningful varietal distinctions, the varietal rank might be appropriate to accommodate some of the diversity within certain subspecies in Europe.

The constancy of characters expressed in the taxa of *Sagina* is important in determining the reliability of characteristics for delineating taxa. As the taxa of *Sagina* are highly variable, presence of a particular characteristic or a combination of characters must be regarded as more reliable and indicative of a taxon than absence. The following characters are particularly noteworthy.

Two types of seeds occur and I have found them to be diagnostic of sectional subdivisions of the genus. The saginoid seed type, characteristic of sect. *Sagina,* is obliquely triangular, possesses a dorsal groove, and its sides are drawn inward (Figure 4a). The crassuloid seed type, characteristic of sect. *Maxima,* is more nearly reniform or globose, lacks a dorsal groove, and its sides remain full and plump (Figure 4b). I regard the crassuloid seed type as primitive in the genus, and only two species in the genus, *Sagina nodosa* and *S. abyssinica,* express intermediacy in this character.

Leaf succulence is likewise sufficiently stable to be used as a character state for distinguishing sect. *Maxima* from sect. *Sagina.*

Presence or absence of pubescence at the base of the calyx and upper portion of the pedicel is reliable in some species. However, in *Sagina nodosa* and in *S. decumbens* ssp. *decumbens* and ssp. *occidentalis,* presence of pubescence is not consistent within populations or even on a single plant. In the North American populations of *S. caespitosa* glandular pubescence is sometimes only a weakly expressed character.

One character frequently used as distinctive in *Sagina saginoides, S. procumbens* and *S. subulata* is the reflexed nature of the pedicel on fruiting specimens. Actually, the pedicels are recurved only during capsular development and become erect at the time of capsular dehiscence. Often this character is not visible in herbarium specimens, but when it is present the character is reliable.

Figure 7. *Sagina nodosa* ssp. *borealis*. a. living specimen, Lake Superior, Ontario; b. herbarium specimen, Lake Superior, Ontario (*Voss 11319*, MICH).

The character state of tetramerous versus pentamerous flowers has previously been regarded as very important not only in the delineation of taxa, but especially in characterizing infrageneric categories. In several taxa, however, both tetramerous and pentamerous flowers may occur on a single plant. In each case, one of the flower forms will predominate, and caution must be exercised regarding the use of this as a key character. The character state of tetramerous versus pentamerous flowers is not useful at all for distinguishing the infrageneric categories recognized in this study.

ACKNOWLEDGMENTS

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During my field work several persons took time to guide me to collecting sites: Drs. E. K. Longpre and H. Barclay in Colorado, Dr. J. H. Thomas in California and Dr. E. G. Voss in Ontario. Mr. Robert L. Watson accompanied me in the field. Special thanks are extended to Dr. H. Z. Snyder who provided travel support for field work through the Snyder Foundation.

Dr. J. K. Morton graciously provided me with his unpublished chromosome counts of North American material of *Sagina*. Dr. William T. Stearn kindly provided assistance in the typification of Linnaean species. Financial support from Sigma Xi to study type specimens in England is acknowledged.

I also wish to thank the curators of the herbaria from which specimens were borrowed for this study. These herbaria are listed below with other pertinent information concerning measurements.

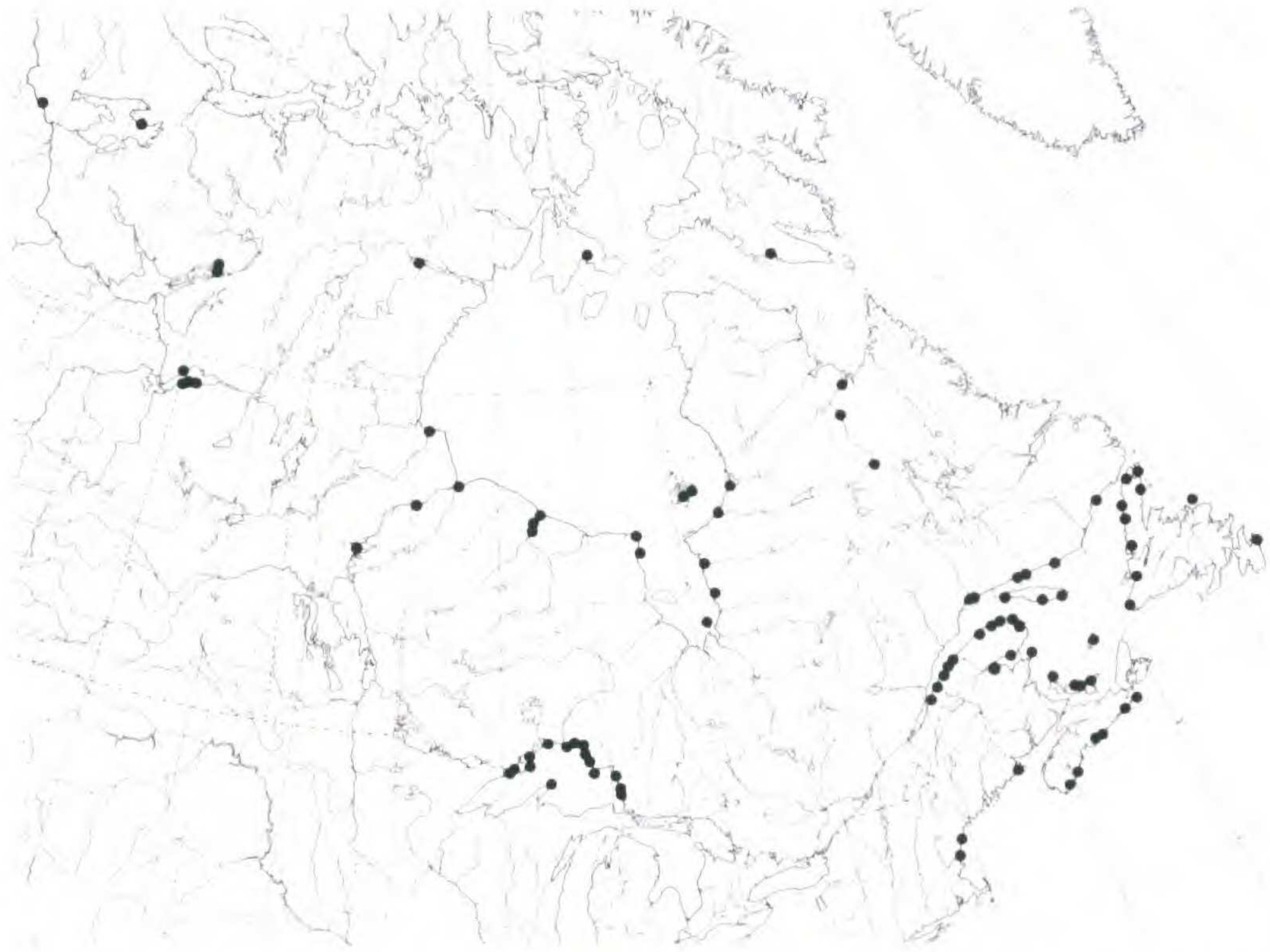

Figure 8. Geographical distribution of *Sagina nodosa* ssp. *borealis* in North America.

SPECIMENS EXAMINED

In this study measurements are based on dried material using a millimeter rule. Measurements of seeds and stamens were made under 30× magnification.

In the citation of herbarium specimens abbreviations of institutions follow those of *Index Herbariorum* 6th edition (Holmgren & Keuken, 1974). Specimens from the following herbaria were examined: BM, C, CAN, CAS, COLO, DAO, DS, F, E, ENCB, GH, JEPS, K, LE, LINN, MICH, MIN, MO, MONTU, MSC, NA, NEBC, NHA, NY, OSC, P, RM, S, TI, UC, US, WAT (University of Waterloo; abbreviation not listed in *Index Herbariorum*), WIS, WS, WTU.

TAXONOMIC TREATMENT

Sagina Linnaeus, Sp. Pl. **1:** 128. 1753.

Alsinella Dillen. ex Hill, Brit. Herb. 225. 1756, in part.

Phaloe Dumortier, Fl. Belg., p. 110. 1827.

Spergella Reichenbach in Moessler, Handb. d. Gewachsk, ed. 2, **1:** 65. 1827.

Low annual or perennial herbs; tufted, caespitose or matted. Stems ascending, decumbent or procumbent, horizontal stems becoming slightly woody in mat-forming species. Basal rosette or basal tuft of leaves present in perennial species, absent or early deciduous in annuals, rarely persisting. Secondary rosettes present in mat-forming species. Stems glabrous or glandular pubescent. Cauline leaves opposite, linear to subulate, scarious-connate at base; non-stipulate. Flowers small, whitish, terminal or axillary, 4- or 5-merous. Calyx base and upper pedicel glabrous or glandular pubescent. Sepals obtuse with scarious margins and obscure veins, cupped and frequently cucullate in bud. Petals undivided, frequently absent or caducous in annual species. Stamens equal to or twice the number of stigmas, in one or two whorls, outer whorl with nectaries at base. Styles the same number as the sepals and alternate with them, recurved at anthesis, inner surface stigmatic, papillose. Capsule many seeded (ca. 125), 4- or 5-valved, sutures running to base, valves opposite the sepals. Seeds (0.25–) 0.3 mm-0.5 (–0.6) mm long, obliquely triangular with dorsal groove or reniform to nearly globose with dorsal groove lacking, smooth, pebbled, papillate or tuberculate.

TYPE SPECIES: *Sagina procumbens* L.; lectotype designated by Britton and Brown (1913) and also adopted by Britton (1918), Hitchcock and Green (1929), and Phillips (1951).

About 15 species, chiefly of the cold temperate Northern Hemisphere. Primary center of diversity, Europe; secondary center of diversity, eastern Asia.

Table 1. **Comparative Features of Sagina Sections Sagina and Maxima**

Character	Sect. *Sagina*	Sect. *Maxima*
Center of diversity	Europe	eastern Asia
Seed type	saginoid	crassuloid
Leaves	not fleshy (sometimes only slightly fleshy)	distinctly fleshy
Flowers	4- or 5-merous; morphology tends to favor inbreeding	5-merous; morphology tends to encourage outbreeding
Sepal length	1.5–2.5 (–3.0) mm	2.0–3.5 mm
Capsule length	1.5–3.0 (–4.0) mm	2.0–4.5 mm

KEY TO NORTH AMERICAN SPECIES AND INFRASPECIFIC TAXA OF SAGINA

a. Flowers with petals nearly twice the length of sepals, 3.0–4.5 mm long; leaves of upper main stem and lateral branches usually bearing axillary fascicles of minute, succulent leaves, giving a "knotted" appearance. (Sect. *Sagina,* in part; see Table 1.) ..... b.
  b. Stems glabrous, occasionally weakly pubescent at the nodes, pedicels and calyx bases glandular pubescent or glabrous. . . . 1b. *S. nodosa* ssp. *borealis.*
  b. Stems, pedicels, calyx bases and frequently leaf margins glandular pubescent. ..... 1a. *S. nodosa* ssp. *nodosa.*
a. Flowers with petals shorter than, equal to, or barely exceeding sepals, up to 2.5 mm long or absent; cauline leaves lacking axillary fascicles of minute succulent leaves. ..... c.
  c. Flowers 5-merous; leaves succulent; seeds reniform or nearly globose, plump, lacking a dorsal groove. (Sect. *Maxima;* see Table 1.) ..... d.
    d. Seeds dark brown, distinctly tuberculate. ..... 10. *S. japonica.*
    d. Seeds reddish-brown, smooth or slightly pebbled. ..... e.
      e. Calyx bases and upper portion of pedicels glandular pubescent ..... 9a. *S. maxima* ssp. *maxima.*
      e. Plants entirely glabrous. ..... 9b. *S. maxima* ssp. *crassicaulis.*
  c. Flowers 4- or 5-merous; leaves not succulent, or if slightly succulent, then flowers predominantly 4-merous; seeds obliquely triangular, dorsal groove present. (Sect. *Sagina,* in part; see Table 1.) ..... f.
    f. Plants annual; stems capillary; upper cauline leaves subulate, becoming shorter toward apex of stem. ..... g.
      g. Flowers 4-merous; hyaline portion of leaf bases distinctly ciliate, especially of the upper cauline leaves; capsules equaling or barely exceeding sepals. ..... 8. *S. apetala.*
      g. Flowers 5-merous, rarely 4-merous; leaf bases never ciliate; capsules exceeding the sepals. ..... h.
        h. Seeds light tan, with delicate reticulate ridge pattern; surface smooth or tuberculate (Figure 5). ..... 7a. *S. decumbens* ssp. *decumbens.*
        h. Seeds light brown, never with reticulate ridge pattern; surface smooth to slightly pebbled. . . . 7b. *S. decumbens* ssp. *occidentalis.*
    f. Plants perennial; stems not capillary, upper cauline leaves linear, linear-subulate or if subulate, then plants caespitose. ..... i.
      i. Plants caespitose, forming low cushions, cauline leaves subulate; sepal margins purple. ..... j.
        j. Petals exceeding or rarely equaling sepals, 2.5–3.0 mm long; flowers 5-merous, sometimes accompanied by 4-merous flowers; primary basal rosette lacking, several secondary rosettes of linear leaves often present. ..... 6. *S. caespitosa.*
        j. Petals less than or equaling sepals, 1.5–2.0 mm long; flowers 4-merous, sometimes accompanied by 5-merous flowers; primary basal rosette of succulent, subulate leaves present, secondary rosettes absent. ..... 5. *S. nivalis.*

i. Plants ascending, spreading, procumbent or mat-forming, rarely caespitose in alpine plants; leaves linear; sepal margins green or white. . . k.
k. Flowers 4-merous, sometimes accompanied by 5-merous flowers; petals minute, 0.75–1.0 mm long, sometimes absent; sepals divergent at time of capsule dehiscence. . . . . 3. *S. procumbens*.
k. Flowers 5-merous; petals (1.0–) 1.5–2.0 mm long; sepals appressed or at least loosely appressed at time of capsule dehiscence. . . . . l.
l. Plants completely glabrous; leaf tips apiculate. 2. *S. saginoides*.
l. Plants with leaves, stems, pedicels and calyx bases glandular pubescent; leaf tips aristate, arista long, equaling or exceeding leaf width. . . . . 4. *S. subulata*.

Sagina L. sect. **Sagina**

Spergella (Reichb.) Koch, Syn. Fl. Germ. et Helv., p. 109. 1835, as section in *Spergula*. *Spergella* (Reichb.) Koch, Syn. Fl. Germ. et Helv., ed. 2, p. 117. 1843, as section in *Sagina*.

Spergella (Reichb.) Williams, Jour. Bot. **34:** 427. 1896, as subgenus in *Sagina*. TYPE: *Sagina nodosa* (L.) Fenzl (lectotype designated herein).

Saginella Koch, Syn. Fl. Germ. et Helv., ed. 2, p. 117. 1843, as section in *Sagina*. TYPE: *Sagina procumbens* L.

Eusagina Williams, Jour. Bot. **34:** 427. 1896, as subgenus in *Sagina*. TYPE: *Sagina procumbens* L.

Procumbentes Williams, Jour. Bot. **34:** 427. 1896, as section in *Sagina*. *Procumbentes* (Williams) Williams, Rep. Bot. Soc. & Exch. Club Br. Isl. **5:** 191. 1918, as subsection in *Sagina*. TYPE: *Sagina procumbens* L.

Maritimae Williams, Jour. Bot. **34:** 427. 1896, as section. *Maritimae* (Williams) Williams, Rep. Bot. Soc. & Exch. Club Br. Isl. **5:** 192. 1918, as subsection in *Sagina*. TYPE: *Sagina maritima* G. Don (lectotype designated herein).

Nodosae Moss, Cambr. Br. Fl. **3:** 24. 1920, as series in *Sagina*. TYPE: *Sagina nodosa* (L.) Fenzl.

Subulatae Moss, Cambr. Br. Fl. **3:** 24. 1920, as series in *Sagina*. TYPE: *Sagina subulata* (Sw.) Presl (lectotype designated herein).

Procumbentes Moss, Cambr. Br. Fl. **3:** 24. 1920, as series in *Sagina*. TYPE: *Sagina procumbens* L.

Apetalae Moss, Cambr. Br. Fl. **3:** 24. 1920, as series in *Sagina*. TYPE: *Sagina apetala* Ard. (lectotype designated herein).

Seeds obliquely triangular, possessing a dorsal groove; leaves not fleshy, or if fleshy, then only slightly so. Temperate regions of the world, chiefly Eurasia and North America. TYPE SPECIES: *Sagina procumbens* L.

Figure 9. *Sagina saginoides*. a. habit. b. close-up of fruiting material.

1a. **Sagina nodosa** (L.) Fenzl, Ver. Verbr. Alsin, *tab. ad.* p. 18. 1833. ssp. **nodosa**

Spergula nodosa L., Sp. Pl. **1:** 440. 1753. *Alsine nodosa* (L.) Crantz, Inst. **2:** 408. 1766. *Phaloe nodosa* (L.) Dumort., Fl. Belgica, p. 110. 1827. *Spergella nodosa* (L.) Reichb., Fl. Germ. Excurs. p. 795. 1832. *Sagina nodosa* (L.) E. Meyer, Elench. pl. boruss. p. 29. 1835. *Arenaria nodosa* (L.) Wallr., Sched. Crit. 200, in obs. 1822. *Alsine nodosa* (L.) Krause, in Sturms, Fl. Deutschl. 2 ed., **5:** 34. 1901. TYPE: LINN *604.4.* (Lectotype, LINN!).

Spergula glandulosa Bess., Prim. Fl. Galic. **1:** 298. 1807. *Spergula nodosa* var. *pubescens* (Bess.) Mert. & Koch, in Röhling, Deutschl. Fl. ed. 3, **3:** 362. 1831. *Spergella nodosa* var. *glandulosa* (Bess.) Reichb., Fl. Germ. Excurs. p. 795. 1832. *Sagina nodosa* var. *glandulosa* (Bess.) Asherson, Fl. Brandenb. p. 97. 1860. *Spergella nodosa* var. *glandulifera* Schur, Enum. Pl. Transs. p. 109. 1866. TYPE: not seen. ORIGINAL MATERIAL: In sandy sites in wet meadows of hills. Lvov, Ukraine, U.S.S.R.

Perennial. Basal tufts of short compacted non-flowering branches bearing long linear leaves. Basal leaves ca. 15–30 mm long, usually bearing glandular hairs, especially on margins, sometimes glabrous. Rosettes lacking. Main stems ascending to loosely spreading to prostrate, with none, few, or many lateral branches bearing only subulate leaves, 1 mm long. Lower cauline leaves linear to subulate, apiculate to mucronate; axillary fascicles lacking. Upper cauline leaves subulate, 1.0–1.5 mm long, mucronate. Subulate cauline leaves of main stem and lateral branches with axillary fascicles of succulent subulate leaves, giving 'knotted' appearance. Stems pubescent; nodes frequently purplish. Pedicels pubescent on the uppermost portion. Flowers showy, protandrous, ca. 6–10 mm in diameter, 5-merous or 5- and 4-merous. Calyx glandular pubescent at base. Sepals elliptic, 2–3 mm long; tips frequently purplish; hyaline margins rarely purplish. Petals greatly exceeding sepals, rarely equaling or shorter than sepals, (2–) 3.0–4.5 (–5) mm long. Stamens 10 or 8, filaments 2.0–3.0 mm long, anthers 0.5 mm long. Styles long, 1.0–1.5 mm, upper half stigmatic on inner surface. Capsule valves thick, 3.0–4.0 mm long. Sepals remaining appressed after capsule dehiscence. Seeds dark brown; smooth to distinctly pebbled; ovoid to reniform with a distinct notch present at hilum; dorsal groove present or absent, 0.5 mm long. Chromosome number: $2n = 56$.

ECOLOGY AND DISTRIBUTION: Restricted to coasts, growing in moist crevices of rocks along seashore and on sea cliffs and in wet sand flats at river mouths. From Massachusetts to Nova Scotia,

rare on Newfoundland and reported once from Anticosti Island and the Mingan Islands. Probably introduced. Europe. Flowering July and August. Figure 6.

REPRESENTATIVE SPECIMENS: **Canada.** NEW BRUNSWICK: Charlotte Co., Herring Cove, Campobello Island, *Malte 944/29* (CAN); east side of Whale Cove, Grand Manan Island, *Weatherby & Weatherby 5607* (US). NEWFOUNDLAND: St. Georges, Bay St. George, *Fernald & Wiegand 3344* (NY, US). New World Island, southern shore Notre Dame Bay, *Fernald & Wiegand 5380* (GH). Tilt Cove, northern shore Notre Dame Bay, *Fernald & Wiegand 5381* (CAN, GH, NY). NOVA SCOTIA: Anapolis Co., Victoria Beach, *Adams s.n.*, 31 July 1937 (DAO). Digby Co., Digby Neck, Bay of Fundy shore, *Cox s.n.*, 28 July 1919 (DAO); Brier Island, *Smith, Roland, Collins, Erskine & Schofield 13* (DAO). Halifax Co., West Lawrencetown, *Bell & Erskine s.n.*, 21 July 1949 (DAO). Queens Co., near mouth of Broad River, *Fernald & Bissell 21195* (CAN, GH). Shelburne Co.: Round Bay, *Prince & Atwood 1295* (WIS). QUEBEC: Anticosti Island Co., peat bog at Salt Lake, *Macoun 24033* (CAN, US). Matane Co., 15 mi. east of Mont Joli, *Bassett & Crompton 4321* (DAO). Saguenay Co., Ile à Charre, Mingan Islands, *St. John 90417* (GH); Ile St. Geneviève, Mingan Islands, *St. John 90418* (GH). **France.** ISLES ST. PIERRE ET MIQUELON: Isthme de Langlade, *Arsène 249* (GH).

United States. MAINE: Cumberland Co., Western Brown Cow, Casco Bay, *Chamberlain & Norton 1116* (US); Bailey's Island, Harpswell, *Cushman 3968* (MIN). Hancock Co., Seal Harbor, Mount Desert Island, *Rand s.n.*, 21 July 1903 (UC). Knox Co., Matinicus Island, *McAttee s.n.*, 4 November 1915 (US). Lincoln Co., Thrumcap Island, off Boothbay, *Churchill s.n.*, 10 July 1903 (MIN, MO, NHA); Thread-of-Life Ledges, Bristol, *Fassett 10375* (F, WIS); White Island, *Fassett 2428* (WIS); Southport, *Fernald s.n.*, 4 August 1894 (GH, MIN); Pemaquit Pt., *Hodgdon 5728* (DAO, NHA); Lighthouse Hill, Monhegan Island, *Hodgdon & Hodgdon 16154* (NHA); Monhegan Island, *Jenney, Churchill & Hill s.n.*, 2 July 1919 (MIN, MO). Sagadahoc Co., near Popham Beach, Fox Island, *Hodgdon 6802* (NHA); Griffith Head, Georgetown Island, *Hodgdon 7401* (NHA); Indian Point, Georgetown Island, *Hodgdon 411* (NHA). Washington Co., Joe Dyer's Point, Baldwin Head, *Walder 4054* (US). York Co., Cape Elizabeth, *Blake s.n.*, 25 August 1857 (F, NY); Kennebunk, *Chickering s.n.*, August 1875 (DS, US); Biddeford Pool, *Clark s.n.*, 3 September 1955 (US); York, sea ledges southwest of Bald Head Cliff, *Hodgdon 10594* (NHA); Kennebunkport, *Morong s.n.*, August 1878 (F). MASSACHUSETTS: Essex Co., Manchester, *Chamberlain s.n.*, date unknown (NY); Cape Ann, 1 mi. north of Rockport, *Churchill s.n.*, 8 July 1944 (MSC); Gloucester, near Long Beach, *Williams s.n.*, 14 August 1898 (GH). NEW HAMPSHIRE: Rockingham Co.: Isle of Shoals, *Oakes & Robbins s.n.*, date unknown (GH, NHA, NY, US).

Sagina nodosa was first described by Linnaeus in *Hortus Cliffortianus* (1738). However, the diagnostic polynomial published in *Species Plantarum* (1753) differed significantly by the addition of "foliis subulatis laevibus" which indicates that he took his con-

cept of the species from material he had studied later in the preparation of *Species Plantarum.* The Linnaean Herbarium at the Linnean Society of London contains a specimen, LINN *604.4,* upon which Linnaeus has written "3 nodosa" (3 being the species number in *Species Plantarum*) and which was probably available to him in his preparation of *Species Plantarum.* This specimen, which belongs to the species to which the name *Sagina nodosa* is currently applied, is hereby designated as the lectotype of the basionym, *Spergula nodosa* L.

The presence of only the short, descriptive phrase-name in *Species Plantarum* has led to some confusion in subsequent recognition of infraspecific taxa. The inclusion of "foliis subulatis laevibus" implied a glabrous plant. Besser (1807) later described a new species from the Ukraine, *Spergula glandulosa* (subsequently treated as *Sagina nodosa* var. *pubescens* (Besser) Mert. & Koch), provided a very detailed description and noted that it differed from *Spergula nodosa* L. by the presence of glandular pubescence on the stem and linear leaves. Upon examination of LINN *604.4* I discovered that while the subulate leaves are indeed glabrous, many of the linear basal leaves are glandular pubescent, particularly along the margins and midrib. Likewise the stems bear glandular hairs. Since Besser's taxon does not differ from Linnaeus' the name *Sagina nodosa* var. *pubescens* (Besser) Mert. & Koch is relegated to the ranks of synonomy. This leaves the taxon previously known as var. *nodosa* as an unnamed taxon and thus it is described as a new subspecies in this paper.

In addition to the characteristic stem pubescence and frequent leaf pubescence of *Sagina nodosa* ssp. *nodosa* there is a tendency in this taxon for basal leaves to appear more rigid and the midveins more prominent in herbarium material. The wrinkled texture of these leaves suggests they are slightly more succulent than those of ssp. *borealis.*

Some variation occurs in the amount and distribution of pubescence on the leaf surface in *Sagina nodosa* ssp. *nodosa.* In plants with a lesser amount of pubescence the glandular hairs are restricted chiefly to the leaf margins. In more pubescent plants the trichomes are more frequent along the veins on the abaxial surface as well as the leaf margins. The leaves may be glabrous.

Figure 10. Geographical distribution of *Sagina saginoides* in North America.

1b. **Sagina nodosa** (L.) Fenzl ssp. **borealis** Crow, ssp. nov. TYPE: *J. F. Collins & M. L. Fernald 75.* **Canada.** QUEBEC: Gaspé County, Ste. Anne Des Monts. Brackish shores, covered at high tide. 19 August 1905. (Holotype, MSC-33878; isotypes, CAN, GH, MIN, NY, UC, US).

Sagina nodosa f. *bulbillosa* Polunin, Bull. Nat. Mus. Can. **92:** 205. 1940. TYPE: *Polunin 2312* (cited as *Polunin 2315* in original publication). Lake Harbour, Baffin Island. August 27, 1936. (Holotype! CAN; isotypes, GH!, BM, OXF).

Caulis glaber, raro sparsim glandulose pubescens ad basim nodorum; pars distalissima pedicelli et basis calycis glandulose pubescens vel glabra.

Perennial. Basal tufts of short compacted non-flowering branches bearing long linear leaves, ca. 15–30 mm long. Rosettes lacking. Main stems ascending to loosely spreading to prostrate, with none or few to many lateral branches bearing only subulate leaves, 1 mm long. Lower cauline leaves short-linear to subulate, apiculate to mucronate; axillary fascicles lacking. Upper cauline leaves subulate, 1.0–1.5 mm long; mucronate. Subulate cauline leaves of main stem and lateral branches with axillary fascicles of succulent subulate leaves, giving 'knotted' appearance. Stems glabrous or rarely weakly pubescent at nodes; nodes frequently purplish. Pedicels glabrous or pubescent on the uppermost portion. Flowers showy, protandrous, ca. 6–10 mm in diameter, 5-merous or 5- and 4-merous. Calyx glabrous or glandular pubescent at base. Sepals elliptic, 2–3 mm long; tips frequently purplish; hyaline margins rarely purplish. Petals greatly exceeding sepals, rarely equaling or shorter than sepals; (2–) 3.0–4.5 (–5) mm long. Stamens 10 or 8, filaments 2.0–3.0 mm long, anthers 0.5 mm long. Styles long, 1.0–1.5 mm, upper half stigmatic on inner surface. Capsule valves thick, 3.0–4.0 mm long. Sepals remaining appressed after capsule dehiscence. Seeds dark brown, 0.5 mm, ovoid to reniform, a distinct notch present at hilum, dorsal groove present or absent, smooth to distinctly pebbled. Chromosome number: $2n = 44, 56$. Figure 7.

ECOLOGY AND DISTRIBUTION: A shoreline plant occurring in rock crevices, wet gravels and sands and in tufts of moss along rocky coasts from New England north to Newfoundland and infrequently to Baffin Island, along the St. Lawrence Seaway, on the shores of Hudson and James Bays and Lake Superior and occasionally on lake shores westward to Lake Athabaska and Great Slave Lake. The taxon appears to be absent in the region of the Clay-belt of Ontario between James Bay and Lake Superior (Soper, 1963). Amphi-Atlantic. Flowering July and August. Figure 8.

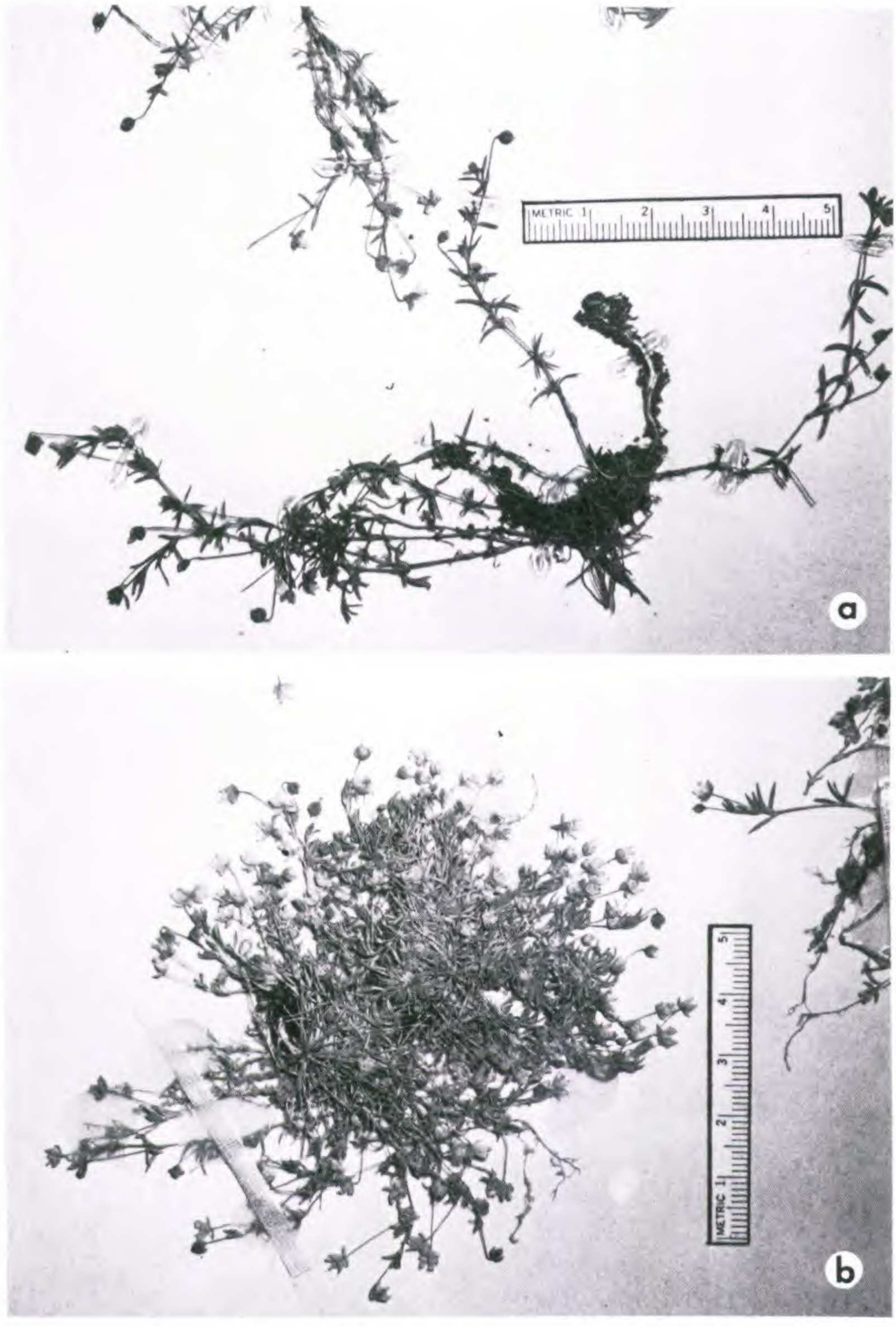

Figure 11. *Sagina procumbens*. a. habit, Quebec, (*Marie-Victorin, Rolland-Germaine, Raymond & Rouleau 56363*, GH); b. habit, Newfoundland (*Bassett 541*, DAO).

REPRESENTATIVE SPECIMENS: **Canada.** ALBERTA: Sand Point, north shore of Lake Athabaska, 58°51′N., 110°50′W., *Raup 701* (GH). MANITOBA: Cochran River, 58°02′ N., 101°23′W., *Baldwin 2118* (CAN). Muskey Island, Lake Winnipeg, *Macoun s.n.*, 4 August 1884 (CAN). Vicinity of Churchill, 58°46′N., 94°10′W., *Schofield & Crum 6896* (DS, MIN, WTU). Gillman, Churchill District, *Schofield 1209* (WS). Pipestone Lake, 35 mi. north of Lake Winnipeg at entrance of Nelson River, *Scoggan 3379* (CAN). York Factory, *Scoggan 6165* (CAN, GH, MIN). NEW BRUNSWICK: Charlotte Co., Whale Cove, Grand Manan Island, *Weatherby & Weatherby 5581* (GH). Gloucester Co., Miscou Point, Miscou Island, *Dore, Senn & Gorham 45.621* (DAO); Younghall, *Fletcher 784* (CAN, DAO). Restigouche Co., Eel River, *Chalmers s.n.*, September 1875 (CAN). NEWFOUNDLAND: Bonne Bay, near Winterhouse Brook, *Fernald, Long & Fogg 1666* (GH, US). Cow Head, region north of St. Paul's Bay, *Fernald & Wiegand 3341* (CAN). Flower Cove, Straits of Belle Isle, *Fernald, Long & Dunbar 26650* (NY). Port Saunders Harbor, region of Ingornachoix Bay, *Fernald & Wiegand 3343* (GH). Near Frenchman's Cove, Bay of Islands, *Griscom s.n.*, 8 August 1920 (GH). Stephenville Crossing, *Kennedy 438* (GH). Daniel's Harbour, *Rouleau 5115* (CAN, DAO, US). Englee, *Savile 2664* (DAO). St. Anthony, Cremailère Bay, *Savile & Vaillancourt 2381* (DAO). Fogo Island, *Sornborger s.n.*, 7 August 1903 (CAS, GH, NY, US). NOVA SCOTIA: Guysborough Co., Canso, *Fowler s.n.*, 7 August 1901 (US). Halifax Co., Halibut Cove, near Halifax, *Dore, Senn & Gorham 45.513* (DAO). Queens Co., Port Mouton, *Graves, Long & Linder 21198* (GH). Shelburne Co., Villagedale, *Fernald, Long & Linder 21197* (GH). NORTHWEST TERRITORIES: District of Franklin, Lake Harbour, Baffin Island, *Polunin 2312* (CAN, GH). District of Keewatin, Coral Harbour, Southampton Island, 64°13′N., *Beckett 404* (MIN). Baker Lake, south shore, ca. 64°07′N, 97°W., *Porsild 6119* (CAN, US). District of MacKenzie, Indian Lake, 64°17′N., 115°12′W., *Cody & McCanse 3395* (DAO). Norman Wells, *Cody & Gutteridge 7469* (CAS, DAO, F, MICH, MIN, NY, US). Mackenzie River, opposite Ft. Simpson, *Crickmay 39* (CAN). McTavish Arm, Great Bear Lake, ca. 66°20′N., 119°30′W., *Porsild & Porsild 5175* (CAN). Fairchild Pt., Great Slave Lake, 62°43′N., 109°10′W., *Raup 705* (GH). ONTARIO: Lake River, James Bay, 54°20′N., *Dutilly & Lepage 16784* (CAN, GH). Between Limestone and White Seal Rapids, Severn River, *Moir 1196* (CAN, MIN). Vicinity of mouth of the Severn River, *Moir 1359* (CAN, MIN). Severn River at mouth of the Beaver River, *Moir 266* (MIN). Algoma District, Vrooman Island, in Lake Superior, *Cowell 25* (DAO); 3 mi. southwest of Mica Bay, Lake Superior, *Parmelee & Savile 3674* (DAO); Old Woman Bay, Lake Superior, ca. 16 mi. southwest of Wawa, *Voss 11319* (MICH). Thunder Bay District, Rossport, Lake Superior, *Crow 1297* (MSC); Michipicotin Island, Lake Superior, *Macoun s.n.*, 24 July 1869 (CAN); shore of Lake Superior at Heron Bay, ca. 6 mi. southeast of Marathon, *Voss 10441* (MICH). PRINCE EDWARD ISLAND: Kings Co., between South Lake and the Gulf, near Bothwell, *Fernald, Long & St. John 7446* (CAN, GH, NY, US). Prince Co., Lower Sea Cow Pond, *Fernald, Long & St. John 7443* (CAN, GH, WS). Queens Co., Dalvay, National Park, *Erskine 1532* (DAO, NY). QUEBEC: Great Whale River, near mouth, east coast of Hudson Bay, *Abbe & Abbe 3929* (CAN, MIN, US). Fort George, east coast of James Bay, 53°53′N., *Dutilly & Lepage 12706* (GH). Koksoak River, Ungava basin, 57°40′–58°05′N., 68°25′–69°35′W., *Dutilly & Lepage 14731* (GH). Near Lake Otelnuc, 56°01′N., 68°09′W., *Dutilly & Lepage 39233* (DAO). Anticosti Island Co., Cape Henry, *Adams s.n.*, 6 August 1936 (DAO); Salt Lake, *Macoun 24033* (NY). Bonaventure Co., Carleton

Point, Carleton, *Collins & Fernald 66025* (CAN, GH, MICH, NY, US). Gaspé-Est Co., Grand Vallés, *Clausen & Trapido 3054* (MIN, US). Bay of Gaspé, Riviere York, *Marie-Victorin, Brunel, Rolland-Germain & Rousseau 17726* (GH). Gaspé-Ouest Co., Ste-Anne-des-Monts, *Collins & Fernald 75* (CAN, GH, MIN, MSC, NY, UC, US). Magdalen Islands Co., Alright Island, *Fernald, Long & St. John 7445* (CAN, GH, NY, US). Matane Co., Matane, mouth of Matane River, *Forbes s.n.*, 3 August 1904 (CAN, GH). Rimouski Co., Cape Enragé, Bic, *Fernald & Collins 1019* (GH). Riviere-De-Loup Co., Trois-Pistoles, *Mulligan & Beales 3209* (DAO). Saguenay Co., Wolf Bay, *Lewis 131997* (CAN); Seven Islands, *Robinson 674* (CAN, GH, NY). SASKATCHEWAN: Small island at base of Charlot Pt., Lake Athabaska, ca. 59°36'N., 109°13'W., *Raup 6379* (CAN, DAO, GH, NY).

United States. MAINE: York Co., Kennebunk, *J. W. C., Jr.* [Chickering] *s.n.*, 25 July 1877 (UC). Washington Co., Cutler, *Fernald s.n.*, 28 August 1902 (GH); Rogue Bluff, *Knowlton s.n.*, 31 July 1916 (MO). MICHIGAN: Keweenaw Co., Rock Harbor, Isle Royale, *Cooper 65* (MIN, US). MINNESOTA: Cook Co., Clark Bay, Pigeon Point, *Butters, Abbe & Abbe 385* (F, MIN, US). NEW HAMPSHIRE: Rockingham Co., Isle of Shoals, *Oakes & Robbins s.n.*, date unknown (NY).

Sagina nodosa is the most clearly defined species of the genus and its floral morphology apparently most nearly represents that of the ancestral type.

The glandular and glabrous pedicel characteristics in *Sagina nodosa* ssp. *borealis* are frequent throughout the greater portion of the geographical range and are often found within a single population. The glandular condition is slightly predominant and populations occurring in the interior region of Canada are almost entirely of the glandular pedicel type.

In populations along the shores of Lake Superior plants sometimes occur with glandular hairs sparsely distributed on the stems, chiefly or solely at the base of the nodes, as well as on the pedicels and calyx.

Polunin (1940) described a form from Baffin Island, *Sagina nodosa* f. *bulbillosa*, which occurs totally without flowers and produces bulbils in the axils of the cauline leaves. The disarticulation of these tiny fascicles of leaves in late autumn is a normal mechanism of vegetative dispersal which occurs with greatest frequency in higher latitudes. The mechanism is not restricted to sterile plants and nomenclatural recognition of this condition is meaningless.

It appears that a typographical error was made in the citation of the holotype of *Sagina nodosa* f. *bulbillosa* in the original publication. The type specimen designated was *Polunin 2315*, but no specimen bearing this collection number can be found at the National Museum of Canada, depository designated for the holotype, or at

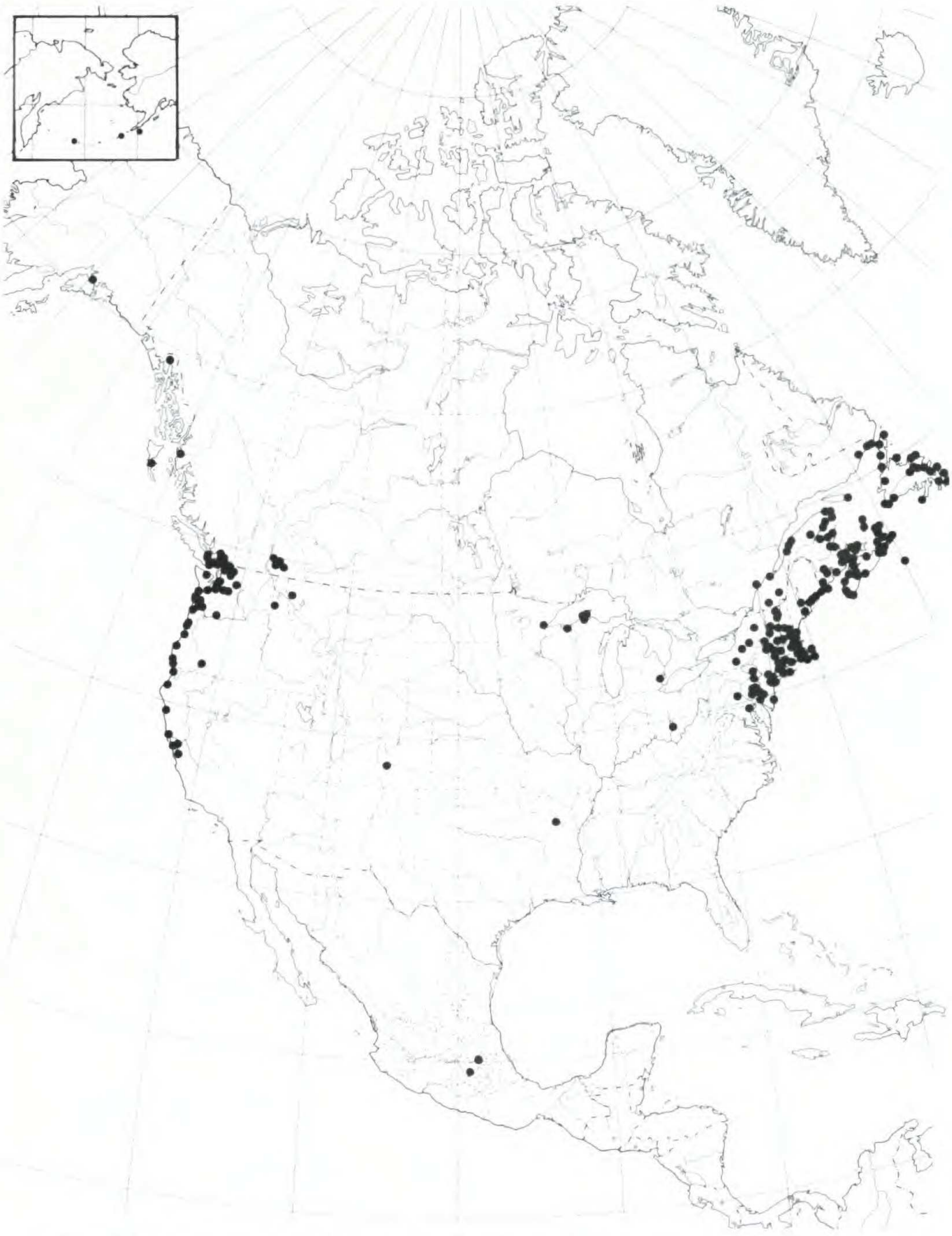

Figure 12. Geographical distribution of *Sagina procumbens* in North America.

the Gray Herbarium, depository designated for an isotype. The only specimens at either institution collected on Baffin Island bear the collection number *Polunin 2312.* With the exception of the last digit of the collection number, the label data for these two sheets are identical to the data published for the type.

2. **Sagina saginoides** (L.) Karst., Deutsch. Fl. p. 539. 1882.

Spergula saginoides L., Sp. Pl. **1:** 441. 1753. *Alsine saginoides* (L.) Crantz, Inst. **2:** 408. 1766. *Phaloe saginoides* (L.) Dumort., Fl. Belgica, p. 110. 1827. *Sagina Linnaei* Presl, Rel. Haenk **2:** 14. 1831. *Nom. superfl.* for *Spergula saginoides* L. *Spergella saginoides* (L.) Reichb., Fl. Germ. Excurs., p. 794. 1832. *Sagina spergella* Fenzl, Ver. Verbr. Alsin., tab. ad. p. 18. 1833. *Nom. illeg. Alsinella saginoides* (L.) Greene, Fl. Fran. p. 125. 1891. *Alsine Linnaei* (Presl) Krause, in Sturms, Fl. Deutschl. 2 ed., **5:** 35. 1901. *Nom. illeg.* TYPE: LINN *604.6.* "Habitat in Sibiria". (Lectotype, LINN!)

Sagina saginoides var. *hesperia* Fern., Rhodora **27:** 131. 1925. TYPE: *Crandall 89*, 9500 ft., Chambers Lake, Colorado. (Holotype, GH!)

Spergula micrantha Bunge, in Ledeb. Fl. Alt. **2:** 183. 1830. *Sagina micrantha* (Bunge) Fern., Rhodora **27:** 131. 1925. TYPE: pr. Barnaul, Tomskoi Sawod. (Lectotype, LE!).

Spergula saxatilis Wimm., Fl. Schles. p. 193. 1832. *Sagina saxatilis* (Wimm.) Wimm. Fl. Schles. p. 75. 1841. *Spergella saxatilis* (Wimm.) Schur, Enum. Pl. Transs. p. 109. 1866. TYPE: not seen. ORIGINAL MATERIAL: grass-covered rocky sites in mountains, near Waldenburg and Einsiedel, Silesia (Germany).

Spergella macrocarpa Reichb., Ic. Fl. Germ. **5:** 26. 1841. *Sagina macrocarpa* (Reichb.) Maly, Enum. Pl. Phan. p. 292. 1848. *Sagina Linnaei* var. *macrocarpa* (Reichb.) Beck, Fl. Nied.-Öst. p. 358. 1890. *Nom. illeg. Sagina saginoides* var. *macrocarpa* (Reichb.) Moss, in Jour. Bot. **52:** 60. 1914. *Sagina saginoides* ssp. *macrocarpa* (Reichb.) Soó, in Acta Bot. Acad. Sci. Hung. **18:** 177. 1973. TYPE: destroyed.

Sagina Baumgarteni Simonkai, Enum. Fl. Transs. p. 144. 1886. TYPE: not seen.

Perennial. Plants tufted, branches ascending or sometimes procumbent, becoming caespitose in alpine habitats. Entire plant glabrous. Rosettes of linear leaves frequently present, 9–45 mm in diameter, or replaced by a tuft of ascending linear leaves. Cauline leaves linear, sometimes linear-subulate in caespitose plants. Connate leaf bases not conspicuous, rarely appearing inflated and then so only in caespitose plants. Axillary fascicles of linear leaves frequently on procumbent stems. Flowers axillary or terminal. Pedicels generally long, filiform, mean length 14.5 mm, recurved during capsular development, becoming erect at maturity. Flowers 5-merous, very rarely 4-merous. Sepals elliptical, hyaline margins white, rarely purple in alpine specimens, 2.0–2.5 mm long. Petals elliptical, (1.0–) 1.5–2.0 mm long, shorter than or equaling the sepals. Stamens 10, or less frequently 5, filaments 1.0–1.5 mm long, anthers 0.25 mm long. Capsules 1.5–2 times the length of the sepals; capsule valves thin, 2.5–3.0 (–3.5) mm long, dehiscing to base. Sepals remaining appressed following capsule dehiscence. Seeds brown, obliquely triangular, with distinct dorsal groove, surface

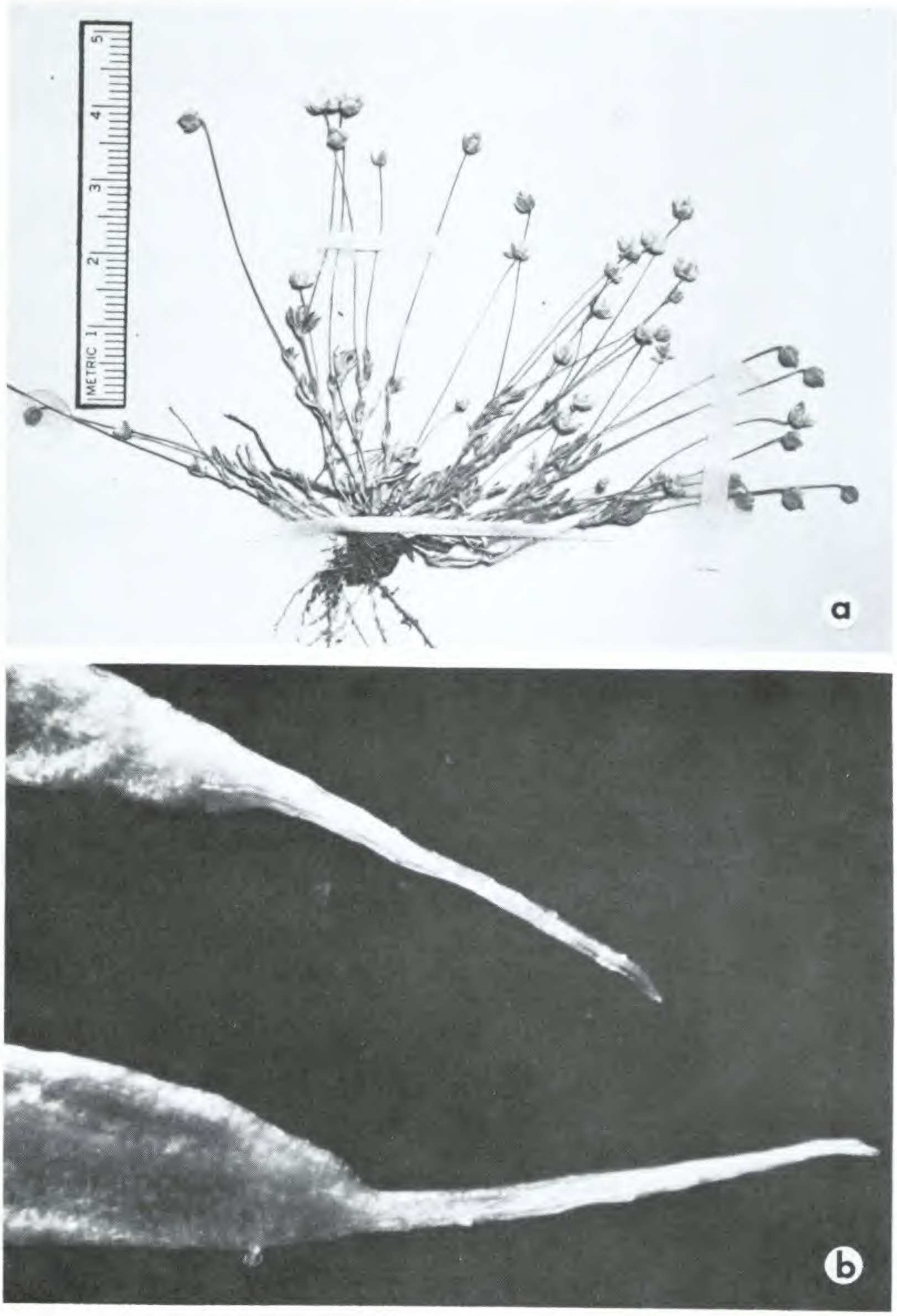

Figure 13. *Sagina subulata*. a. habit. Sweden (*Särnquist s.n.*, 20 June 1948, DAO); b. close-up of aristae, photographed under epi-illumination, Sweden (*Bagge s.n.*, 16 June 1890, UC).

smooth to slightly pebbled, 0.3–0.4 mm long. Chromosome number: $2n = 22$. Figure 9.

ECOLOGY AND DISTRIBUTION: A montane species growing in the open or in light shade in wet places on lake margins, along streams and seepages in rock ledges and roadcuts, often in subalpine and alpine zones. From Alaska, south to Arizona and New Mexico. Its occurrence is rare in eastern North America. I have seen collections only from Richmond Gulf on Hudson Bay, the Schefferville area of the Labrador-Quebec Peninsula and on the Gaspé Peninsula, Quebec. Circumpolar. Flowering June to August. Figure 10.

REPRESENTATIVE SPECIMENS: **Canada.** ALBERTA: Bertha Lake, Waterton Lakes National Park, elev. 6000 ft., *Breitung 16239* (NY). Malique Lake, near headwaters of the Saskatchewan and Athabasca Rivers, *Brown 1176* (GH, MO, NY). Little Beehive Mt., vicinity of Lake Louise, *Hunnewell 3529* (MIN). About 5 mi. east northeast of Bow Peak, Banff National Park, *Hitchcock & Martin 7756* (COLO, DS, GH, MO, NY, OSC, RM, UC, WS, WTU). Crow's Nest Pass, summit of Turtle Mt., *Macoun 18290* (CAN). Mt. Edith Cavell, Jasper National Park, *Scamman 3189* (GH). BRITISH COLUMBIA: Asulkan Valley, Glacier, Selkirk Mts., *Brown 581* (GH, MO, US). About 8 mi. southeast of Barkerville, elev. 5500 ft., *Calder, Savile & Ferguson 14237* (DAO). North of Ft. St. James, Wolverine Lake, 55°41′N., 124°26′W., *Calder, Savile, & Ferguson 13645* (DAO). Between Baldy Mt. and Dunn Peak, ca. 7½ mi. east northeast of Littlefort, ca. 51°27′N., 120°03′W., elev. 7100 ft., *Calder, Parmelle, & Taylor 19908* (DAO, UC). 8 mi. southeast of Nelson along road to Copper Mt., elev. 5400-5700 ft., *Calder & Savile 10993* (DAO). Mt. Apex, southwest of Penticton, elev. 6800 ft., *Calder & Savile 11731* (DAO). Mt. Thornhill, near Terrace, elev. 3800 ft., *Calder, Savile & Ferguson 14871* (DAO). Near Rogers Pass, Selkirk Mts., *Heacock 4400* (GH, MIN, MO, NY, US). Victoria Lake, ca. 11 mi. west of Revelstoke, elev. 1785 ft., *Hitchcock & Martin 7592* (DS, WTU). Battle Mt., Wells Gray Park, 50° N., 120° W., *Ahti & Ahti 7003* (WTU). Chilliwack River, *Macoun 34034* (CAN). Lake House, Skagit River, *Macoun 79583* (CAN, NY). Upper Canyon Creek, Golden, *Taylor 6727* (MICH). Sheep Mt., Elk River Valley, 34 mi. north of Natal, *Weber 2347* (COLO, GH, UC, WS). Vancouver Island, below Mt. Burman, near Burman Lake, 49°37′N., 125°44′W., elev. 5000 ft., *Calder & MacKay 32567* (DAO). Along Elk River, Strathcona Provincial Park, 49°46′N., 125°51′W., elev. 2800 ft., *Calder & MacKay 31643* (DAO). Mt. Arrowsmith, *Anderson & Fletcher s.n.*, 7 August 1901 (DAO). Vicinity of Victoria, *Macoun s.n.*, 23 May 1893 (MSC). DISTRICT OF MACKENZIE: Vicinity of Brintnell Lake, ca. 62°05′N., 127°35′W., *Raup & Soper 9159* (GH). YUKON TERRITORY: Canol Rd., upper south fork of MacMillan River, opposite mile 280, *Porsild & Breitung 11300* (CAN). Canol Rd., Rose-Lapie River Pass, mile 98–99, elev. 4000 ft., *Porsild & Breitung 11900* (GH, UC, US). Canol Rd., slopes of Mt. Sheldon, opposite mile 222, elev. 6000 ft., *Porsild & Breitung 11742* (CAN). Vicinity of Mackintosh, mile 1022 Alaska Highway, slopes of Mt. Decoeli, elev. 4000 ft., *Schofield & Crum 8049* (CAN). QUEBEC: Fishing Lake Creek, Richmond Gulf, east coast of Hudson Bay, ca. 56° N., 76° W., *Abbe, Abbe & Marr 4396* (CAN, DAO, MIN, US).

Knob Lake, Schefferville area, Quebec-Labrador Peninsula, ca. 54°45'N., 66°40'W., *Hustich & Kallio 752* (CAN). Gaspé Co., Mt. Albert, elev. 950 m, *Collins & Fernald 74* (CAN, GH, MIN, MSC, NY, UC); 1 mi. above Marten River, River Ste-Anne-des-Monts, *Collins & Fernald s.n.*, 3–17 August 1905 (GH).

Mexico. BAJA CALIFORNIA: La Grulla, Sierra San Pedro Mártir, elev. 2100 m, *Moran 19173* (ENCB); Yerba Buena, Sierra San Pedro Mártir, elev. 2500 m, *Moran & Thorne 14173* (ENCB). HIDALGO: Cerro de las Ventanas, 6 km al N de Pachuca, elev. 2900 m, *Rzedowski 23010* (ENCB). MEXICO: Ameyalco, 73 km de la carretera Amecameca-Tlamacas, elev. 3100 m, *Rzedowski 21864* (ENCB); 12 km al E de Amecameca, sobre la carretera a Tlamacas, elev. 3000 m, *Rzedowski 26720* (ENCB).

United States. ALASKA: Thompson Pass, Richardson Highway, *Anderson 2777* (CAN). Unalaska, *Anderson 4117* (GH). Falls Creek Mine, near Kenai Lake, Kenai Peninsula, 60°26'N., 149°17'W., *Calder 6088* (CAS, DAO). Head of Resurrection Bay, Seward, Kenai Peninsula, 60°07'N., 149°25'W., *Calder 7018* (DAO). Isabel Pass, mile 199 Richardson Highway, 63°32'N., 145°52'W., *Cody & Webster 5824* (DAO). Tangle Lakes area, mountain east of Landmark Gap, Alaska Range, *Gjaerevoll 1293* (CAN). Smith's Dry Lake, Attu Island, Aleutian Islands, *Hardy 385* (GH). Juneau Ice Field, *Heusser 212* (OSC). Mountains southeast of Texas Lake, 20 mi. northwest of Hyder, elev. 4600 ft., *McCabe 8428* (UC). About 15 mi. due east of Berners Bay at Vaughan Lewis glacier, 25 mi. north of Juneau, Alaska, elev. 2800 ft., *Miller 1745* (MSC). Peaceful Valley, Attu Island, Aleutian Islands, *Soule 185* (WTU). Along Salmon River road 3 mi. north of Hyder, *Whited 1208½* (MO, WS). ARIZONA: Coconino Co., San Francisco Mts., elev. 11500 ft., *Knowlton 134* (US); Kaibab Basin, elev. 8200 ft., *Merkle 586* (CAS); Little Park, North Rim Grand Canyon, elev. 8800 ft., *Merkle 601* (CAS). CALIFORNIA: Alpine Co., Carson Pass, elev. 8200 ft., *Jepson 8116* (UC). Amador Co., Silver Lake, elev. 8000 ft., *Newell s.n.*, 24 August 1929 (CAS). Butte Co., Butte Meadows, *Heller 14688* (DS, MO, US). Calaveras Co., Big Meadows, Stanislaus National Forest, *Crow 1175* (MSC, NHA). Del Norte Co., High Prairie Creek, *Jepson 9346* (JEPS). Fresno Co., Pine Ridge, elev. 5300 ft., *Hall & Chandler 135* (MIN, NY, UC, US). Glenn Co., Sheetiron Mt., elev. 5950 ft., *Bacigalupi 4677* (UC). Humboldt Co., Trinity Summit, near Box Camp, elev. 5500 ft., *Tracy 17918* (UC, US, WTU). Inyo Co., Lone Pine Creek Canyon, east slope of Sierra Nevada, elev. 6950 ft., *Alexander & Kellogg 2907* (DS, UC, US). Kern Co., about ½ mi. northeast of Evans Flat, Greenhorn Mts., elev. 5925–2950 ft., *Smith 652* (UC). Lassen Co., Lassen Butte, *Eastwood 1772* (CAS). Madera Co., Long Meadow, elev. 6800 ft., *Hawkes 5204* (UC). Mariposa Co., Yosemite Valley, elev. 3900 ft., *Hall 8879* (DS, US). Modoc Co., 15 mi. southeast of Alturas, elev. 5500 ft., *Hitchcock 6708* (NY, UC, WTU). Mono Co., along California Rt. 120, 5½ mi. west of Ranger Station, Inyo National Forest, elev. 8500 ft., *Crow 1161* (MSC, NHA). Nevada Co., Lytton Creek, Norden, *Jorgesen 501* (DS, WTU). Place Co., Summit Valley, *Howell 18582* (CAS). Plumas Co., slopes across from the Devils Kitchen, Lassen Volcanic National Park, *Gillett 846* (UC). Riverside Co., Deer Springs, San Jacinto Mts., elev. 9000 ft., *Meyer 541* (UC). San Bernardino Co., Big Bear Lake, San Bernardino Mts., *Breitung 15504* (DAO). Shasta Co., Brokeoff Meadows, Lassen Volcanic National Park, elev. 6300 ft., *Gillett 112* (UC). Siskiyou Co., Horse Camp Springs, Mt. Shasta, elev. 8250 ft., *Cooke 11474* (UC); Wagon Camp, Mt. Shasta, elev. 6000 ft., *Crow 1206* (MSC, NHA). Tehama Co., north slope of North Yollow Bolly Peak, *Munz 16679* (CAS, DS, NY). Trinity Co.,

South Fork Mt., *Tracy 19055* (UC). Tulare Co., headwaters of Freeman Creek, north slope of The Needles, Sequoia National Forest, *Bacigalupi, Wiggins & Ferris 2569* (DS, WTU). Tuolumne Co., Mather, *Keck 5318* (CAS, DS, US). Ventura Co., Seymour Creek, *Pierson s.n.*, in 1922(?) (US). COLORADO: Boulder Co., Green Lakes Valley, north of Kiowa Peak, elev. 11500–12000 ft., *Weber & Dahl 8589* (COLO). Clear Creek Co., mountains about the headwaters of Clear Creek, valley near Empire, *Patterson 173* (COLO, F, MICH, MIN, MO, MSC, UC, US). Conejos Co., just south of Platoro, elev. 9900 ft., *Weber 7864* (CAS, COLO, DAO, MIN, RM, WS, WTU). Costilla Co., slope of old Baldy Peak, 8 mi. from Fort Garland, elev. 9700 ft., *Mattoon 179* (COLO). Freemont Co., Lake Creek, 3 mi. west of Hillside, Sangre de Cristo Mts., *Erlanson 1416* (MICH). Gilpin Co., Eldora to Baltimore, elev. 8500–9500 ft., *Tweedy 5535* (RM, NY). Grand Co., East St. Louis Creek, Fraser Experimental Forest, southwest of Fraser, elev. 9500 ft., *Weber 8616* (COLO, DAO, WTU). Gunnison Co., just west of Schofield Pass in Elko Park, 6 mi. northwest of Gothic, *Crow 1147* (MSC, NHA). Lake Co., Twin Lakes, *Clements 421* (NY). La Plata Co., near La Plata, elev. 9000 ft., *Baker, Earle & Tracy 675* (F, MIN, MO, NY, RM, US). Larimer Co., Chamber's Lake, elev. 9500 ft., *Crandall 79* (GH, NY); trail from Platte Gulch to Wheeler Lake, ca. 5 mi. northwest of Alma, elev. 11500 ft., *Weber 8747* (COLO, DAO, MIN, WTU). Routt Co., trail from Columbine to summit of Hahn's Peak, elev. 8400–10800 ft., *Weber 6913* (COLO). San Juan Co., Needle Mt., Tenmile Basin, ca. 18 mi. southeast of Silverton, elev. 12800 ft., *Michener 830* (COLO). Summit Co., near Breckenridge, elev. 9800 ft., *Mackenzie 234* (MO, NY, RM, WIS). IDAHO: Blaine Co., 14 mi. north of Ketchum, Wood River, *Christ 15818* (NY). Boise Co., headwaters of S. Fork Payette River above Sacajawea Hot Springs, 3 mi. north of Elk Lake, Sawtooth Primitive Area, *Hitchcock & Muhlick 9861* (NY, WTU). Boundary Co., north slope of Mt. Rootnaah, *Daubenmire 44379* (WS). Custer Co., on banks of Yankee Fork, near Custer, *Christ 11345* (NY). Franklin Co., Bear River Range, Franklin Basin, *Maguire 21627* (NY). Freemont Co., Red Rock Pass, *Christ 5767* (NY). Idaho Co., west side of Seven Devils Divide, Seven Devils Mts., *Christ 12493* (NY, US). Lemhi Co., South Fork Camas Creek near Sleeping Deer Mt., 4 mi. northwest of Challis, *Hitchcock & Muhlick 11345* (WTU). Shoshone Co., near Sohons Pass, region of the Coeur D'Alene Mts., elev. 1500 m, *Leiberg 1425* (GH, NY, US). Teton Co., Victor, *Merrill & Wilcox 893* (GH, NY, RM, US). Valley Co., valley of Monumental Creek, near old town of Roosevelt, 21 mi. east of Stibnite, *Christ & Ward 1464* (NY). MONTANA: Deer Lodge Co., 4 mi. west of Storm Lake, Anaconda Mts., *Hitchcock & Muhlick 14868* (NY, WIS, WS, WTU). Flathead Co., near Whitefish Divide on Yakinikak Creek, *Mooar 10736* (MSC). Missoula Co., near Lagoon Lake, above Glacier Lake, Mission Mts. Primitive Area, elev. 6500 ft., *Crow 918* (MSC). Gallatin Co., Spanish Basin, elev. 6500 ft., *Rydberg & Bessey 4034* (CAN, NY). Glacier Co., Many Glacier, Glacier National Park, *Jones 5329* (GH). Lincoln Co., Big Cherry Creek, east of Libby, *Harvey 2703* (MONTU). Park Co., Cooke Guard Station, about 2 mi. east of Cooke City, elev. 8000 ft., *Witt 1780* (CAS, COLO, DAO, MIN, NY, UC, WIS, WS, WTU). Ravalli Co., Watchtower Creek Trail, Bitterroot Mts., elev. 5600 ft., *Lackschewitz & Fageraas 633* (MONTU). Sweet Grass Co., Sweet Grass Canyon, Crazy Mts., elev. 6000–7000 ft., *Flodman 447* (MO, NY). NEVADA: Douglas Co., 2 mi. east of junction of Kingsbury & Clear Creek Grades, *Train 3178* (UC). Elko Co., Jarbidge River, 2 mi. south of Jarbidge, *Baker 8636A* (WTU). Esmerald Co., Chiatovitch Creek, *Duran 2801* (UC). Humboldt Co., valley of Lawance Creek,

Santa Rosa Mts., elev. 6000 ft., *Archer 246* (MICH). Nye Co., North Twin River, Toyabe Mts., *Linsdale & Linsdale 658* (CAS). Ormsby Co., head of Fall Creek, elev. 2460 m, *Baker 1332* (GH, MO, MSC, NY, UC, US). Washoe Co., Third Creek, near Mt. Rose, elev. 8500 ft., *Howell 14055* (CAS, WTU). NEW MEXICO: Rio Arriba Co., vicinity of Brazos Canyon, *Standley & Bollman 11043* (US). San Miguel Co., Winsor's Ranch, Pecos River National Forest, elev. 8400 ft., *Standley 4170* (GH, MO, NY, US). Santa Fe Co., Santa Clara Canyon, *Marcelline 1911* (F). OREGON: Baker Co., Hudson Creek, R44E, T6S, sec. 9., *Head 1594* (OSC). Crook Co., vicinity of Laidlaw, *Whited 3216½* (US). Deschutes Co., Diller Glacier, Three Sisters Mts, elev. 7500 ft., *VanVechten 248* (WTU). Grant Co., Strawberry Mt., Blue Mts., elev. 8000 ft., *Maguire & Holmgren 26843* (GH, NY). Harney Co., White Horse Mts., *Griffiths & Morris 464* (US). Hood River Co., White River, S. Mt. Hood; 10 mi. southeast of Mt. Hood, *Lloyd s.n.*, July 1894 (NY). Jackson Co., northern slopes of Mt. Asland, *Rossbach 599* (DS). Josephine Co., near Bolan Lake, Siskiyou Mts., *Hitchcock & Martin 5238* (DS, NY, UC, WS, WTU). Klamath Co., 15 mi. north of Fort Klamath, *Peck 9367* (DS, GH, MO, NY). Lake Co., Cogswell Creek, 8 mi. south of Lakeview, *Peck 15564* (DS, WTU). Lane Co., Scott Lake, McKenzie Pass, *Jones 5769* (WTU). Umatilla Co., 2 mi. north of Tollgate, Blue Mts., elev. 5000 ft., *Crow 1235* (MSC, NHA). Union Co., Indian Creek, Blue Mts., *Darlington 146* (CAS). Wallowa Co., Imnaha Canyon, 24 mi. above Imnaha, *Peck 18379* (DS, NY, WTU). Wasco Co., 15 Mile Meadow, Mt. Hood National Forest, elev. 4500 ft., *Jones 4135* (GH, UC, WTU). UTAH: Beaver Co., vicinity of Big John Flats, Beaver River headwaters, elev. 9000–10000 ft., *Maguire 19834* (GH, WTU). Box Elder Co., Dunn Canyon, Raft River Range, elev. 6500 ft., *Maguire & Holmgren 22176* (GH, NY, UC, US). Cache Co., mountains near Logan, *Shear s.n.*, 9 August 1895 (NY). Daggett Co., Green Lakes, elev. 7500 ft., *Hermann 4824* (MO). Duchesne Co., Moon Lake, Ashley Forest, elev. 8100 ft., *Harrison & Larsen 7704* (MO). Elko Co., Verdi Lake, Ruby Mts., elev. 10450 ft., *Mills & Beach 1575* (UC). Grand Co., north base of Haystack Mt., La Sal Mts., elev. 9300 ft., *Maguire, Richards, Maguire & Hammond 17965* (CAN, WTU). Juab Co., Granite Creek, Deep Creek Range, elev. 7000 ft., *Maguire & Holmgren 21865* (GH, NY, UC, US, WTU). Piute Co., Tate Mine, near Maryville, *Jones 5855* (MSC, NY, RM, UC). Rich Co., Laketown, elev. 6300 ft., *Harrison & Larsen 7956* (MO). Salt Lake Co., Silver Lake, Big Cottonwood Canyon, *Clemens s.n.*, 30 September 1909 (RM, UC). San Juan Co., southeast part of La Sal Mts., elev. 10000 ft., *Goldman & Hitchcock 1473* (MO). Sanpete Co., vicinity of Clayton Peak, Wasatch Mts., elev. 9000 ft., *Stokes s.n.*, 12–26 August 1903 (MO). Sevier Co., Fish Creek Canyon, *Garrett 2596* (NY). Summit Co., Mill Creek, southwest base of Mt. Elizabeth, Uinta Mts., elev. 8500 ft., *Hermann 5897* (MO, RM). Uintah Co., Paradise Park, Uinta Basin, elev. 10000 ft., *Graham 10056* (GH, MO). Utah Co., American Fork Canyon, elev. 8000 ft., *Jones 1362* (CAS, F, MICH, MSC, NY, UC, US, WS, WTU). Wayne Co., Blind Lake, Aquarius Plateau, elev. 10000 ft., *Dixon 758* (F). WASHINGTON: Asotin Co., Blue Mts., *Jones 1876* (WS). Clallam Co., east face of Obstruction Point, elev. 5600 ft., *Meyer 1258* (MO). Chelan Co., northeast side of Snow Lake, Stuart Range, Wenatchee Mts., southwest of Leavenworth elev. 5000 ft., *Crow 1108* (MSC, NHA). Columbia Co., Indian Corral, Blue Mts., *Carlington 146* (WS). Jefferson Co., Mt. Olympus, elev. 5000 ft., *Flett 3043* (WTU). Klickitat Co., Bingen, *Suksdorf s.n.* 18 April 1895 (WS). Okanogan Co., head of Middle Fork of Pasayten River, north of Harts Pass, *Ownbey & Meyer 2312* (DS, MO, NY, UC, WS, WTU). Pend

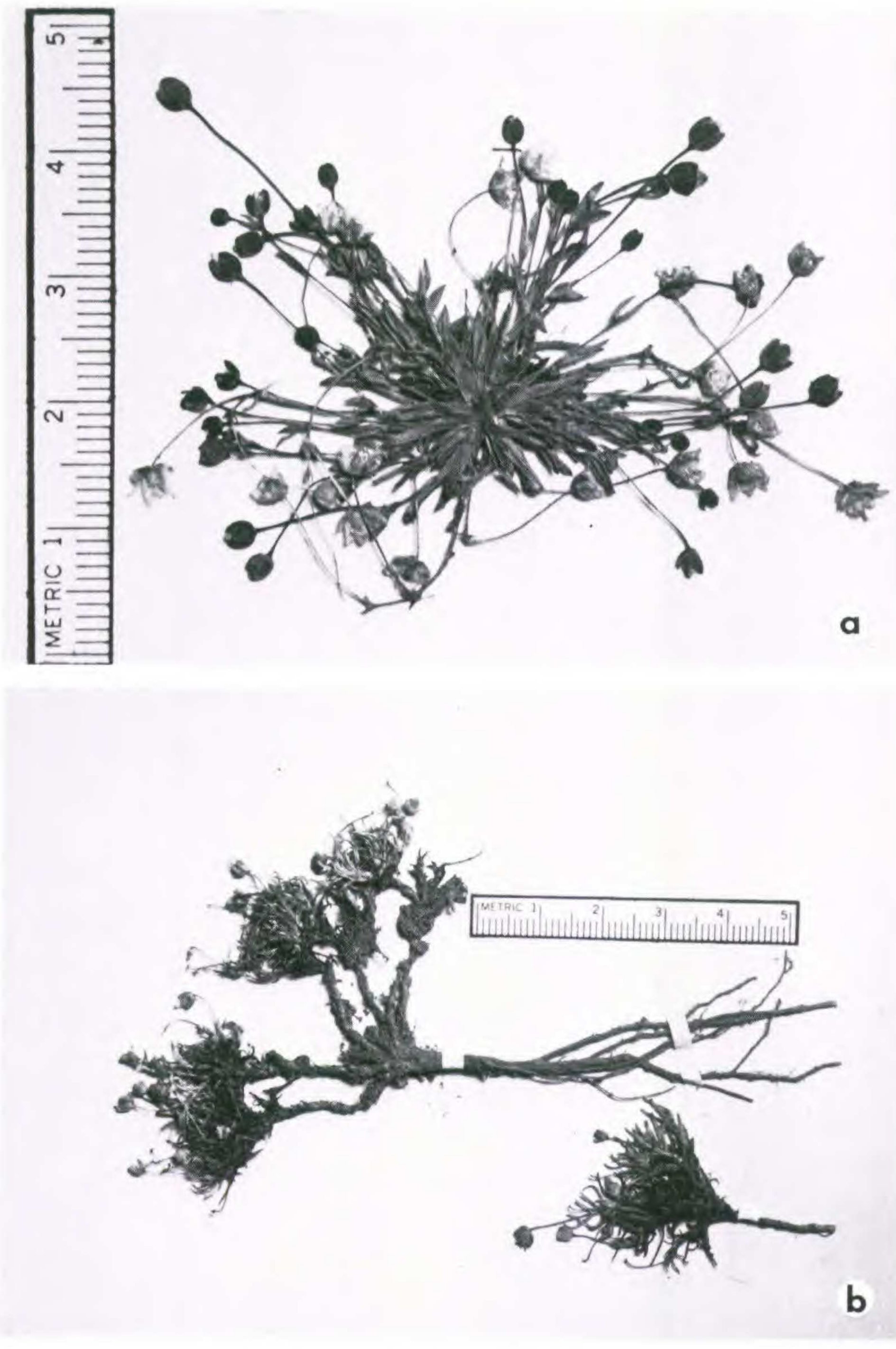

Figure 14. *Sagina nivalis*. a. habit, Axel Heiberg Is., N. W. T. (*Hegg & Beschel 10857*, GH); b. habit, Attu Is., Aleutians (*Jordal & Miller 3077-A*, MICH).

Oreille Co., near Gypsy Meadow, elev. 4800 ft., *Layser 918* (WS). Pierce Co., road to Sunrise glacier, Mt. Rainier, *Crow 1236* (MSC). Whatcom Co., Bagley Lake, near Mt. Baker Lodge, elev. 4300 ft., *Thompson 5700* (DS, MO, WTU). Yakima Co., Wodan's Vale, Mt. Adams, elev. 2000 m, *Suksdorf 6829* (COLO, DS, NY, UC, WS, WTU). WYOMING: Albany Co., Centennial, *Nelson 7728* (GH, MIN, MO, NY, RM, US). Carbon Co., South Spring Creek, Hayden Forest, *Eggleston 11277* (US). Fremont Co., Brooks Lake, near Dubois, *Churchill s.n.*, 18 July 1958 (MSC). Lincoln Co., near junction of Box Canyon Creek and Grey's River, elev. 7800 ft., *Goodman 5133* (RM). Park Co., Beartooth Pass, Beartooth Range, elev. 9200 ft., *Porsild, Johnson & Darling 22753* (CAN). Teton Co., vicinity of Holback Canyon, elev. 7500 ft., *Williams & Pierson 735* (CAS, GH, MO, NY, RM).

The binomial *Spergula saginoides* was published by Linnaeus (1753) in *Species Plantarum*. Although he refers to a Vaillant and Sauvages synonym, his knowledge of the species was certainly based on a Siberian specimen received from Johnn George Gmelin. This species is represented by a specimen at the Linnean Society of London, LINN *604.6*, which bears a note in Linnaeus' handwriting on the back of the sheet stating "Spergula foliis linearibus oppositis . . . Gmel." (W. T. Stearn, 1974, personal communication). The specimen is also annotated by Linnaeus as "5 saginoides," thus relating it to *Species Plantarum*. I feel this specimen is the lectotype.

The combination *Sagina saginoides* Karsten is accepted in *Flora Europea* as having priority, dated at 1882, although Dalla Torre made the same combination in Hartinger's *Atlas der Alpinflora* (1882). I have not been able to confirm the dates of publication.

In reorganizing the specimens of *Sagina* in the Gray Herbarium, Fernald (1925a) noted that the typical phase of *S. saginoides* of the Arctic and Eurasia occurred locally throughout the North American range of the species, but that most of the material of western America had sepals and capsules shorter than those of the typical phase. This American extreme he described as var. *hesperia*.

The Eurasian specimens exhibit considerable variability, the range for sepal and capsule length being continuous (sepals 2.0–3.0 mm long; capsules 2.5–5.0 mm long). Frequently plants of lower elevations tend to be more robust, producing slightly larger flowers, while plants of higher elevations are generally smaller. The more robust, larger flowered plants, with capsules up to 5.0 mm long were first recognized at the specific level as *Spergella macrocarpa* Reichb., and later at the varietal level as *Sagina saginoides* var. *macrocarpa* (Reichb.) Moss. Moss (1914) admits that the discontinuity between the two varieties is trifling, but continues

to recognize two varieties in *S. saginoides* (Moss, 1920). The treatment in *Flora Europaea* (Clapham & Jardin, 1964) notes that the larger flowered plants cannot be clearly separated from typical *S. saginoides* as a distinct taxon.

In this variable species discontinuity appears to be lacking in the characters used to delineate *Sagina saginoides* var. *macrocarpa* and var. *hesperia*. Therefore, I am not recognizing infraspecific categories in this species.

Earlier collections of Reichenbach, which were housed at the Zwinger Museum in Dresden, Germany, were destroyed by fire in May 1849 (Stafleu, 1967). However, the original plates of his *Icones Florae Germanicae et Helveticae* are preserved at Vienna (W).

Another taxon which cannot be regarded as distinct is *Sagina micrantha*. While arranging the specimens of *Sagina* in the Gray Herbarium, Fernald (1925) found it desirable to make the combination *Sagina micrantha* (Bunge) Fern. based on five specimens from the Aleutians and St. Paul Island. These specimens annotated by Fernald belong to *Sagina nivalis*. The original description for the taxon is not descriptive of *S. nivalis*. After study of Bunge's original material preserved at the Komarov Botanical Institute in Leningrad, the specimen representing *Spergula micrantha* Bunge is clearly seen as *Sagina saginoides*, and I herein designate Bunge's specimen "pr. Barnaul, Tomskoi Sawod" as the lectotype for *Spergula micrantha* Bunge.

3. **Sagina procumbens** L., Sp. Pl. **1:** 128. 1753.

Alsine procumbens (L.) Crantz, Inst. **2:** 404. 1766. TYPE: unknown. "Habitat in Europae, pascuis sterilibus uliginosis aridis."

Sagina procumbens var. *compacta* Lange, Meddel. Groenl. **3:** 242. 1887. TYPE: unknown. ORIGINAL MATERIAL: Igaliko, Greenland. Collected by Vahl. (Not at C).

Sagina muscosa Jord., Pugill. Pl. Nov. p. 32. 1852. TYPE: "C. Martin. Pl. de ENV. de LYON, 1851. Bords des chemin an Mt. Pilat (Loire). 20 Juil." (Lectotype, P, designated herein)

Sagina corsica Jordan, Obs. Pl. Crit. **7:** 15. 1849. TYPE: "Corse, Cagnone, juillet 1840. Jordan." (Lectotype, P, designated herein)

Perennial. Plants totally glabrous. Stems ascending or, more frequently, procumbent. Rosettes of linear leaves frequent in younger plants, 9–35 (–55) mm in diameter. Procumbent stems with axillary fascicles giving rise to secondary tufts or, less frequently, secondary rosettes, rooting at the nodes. Cauline leaves

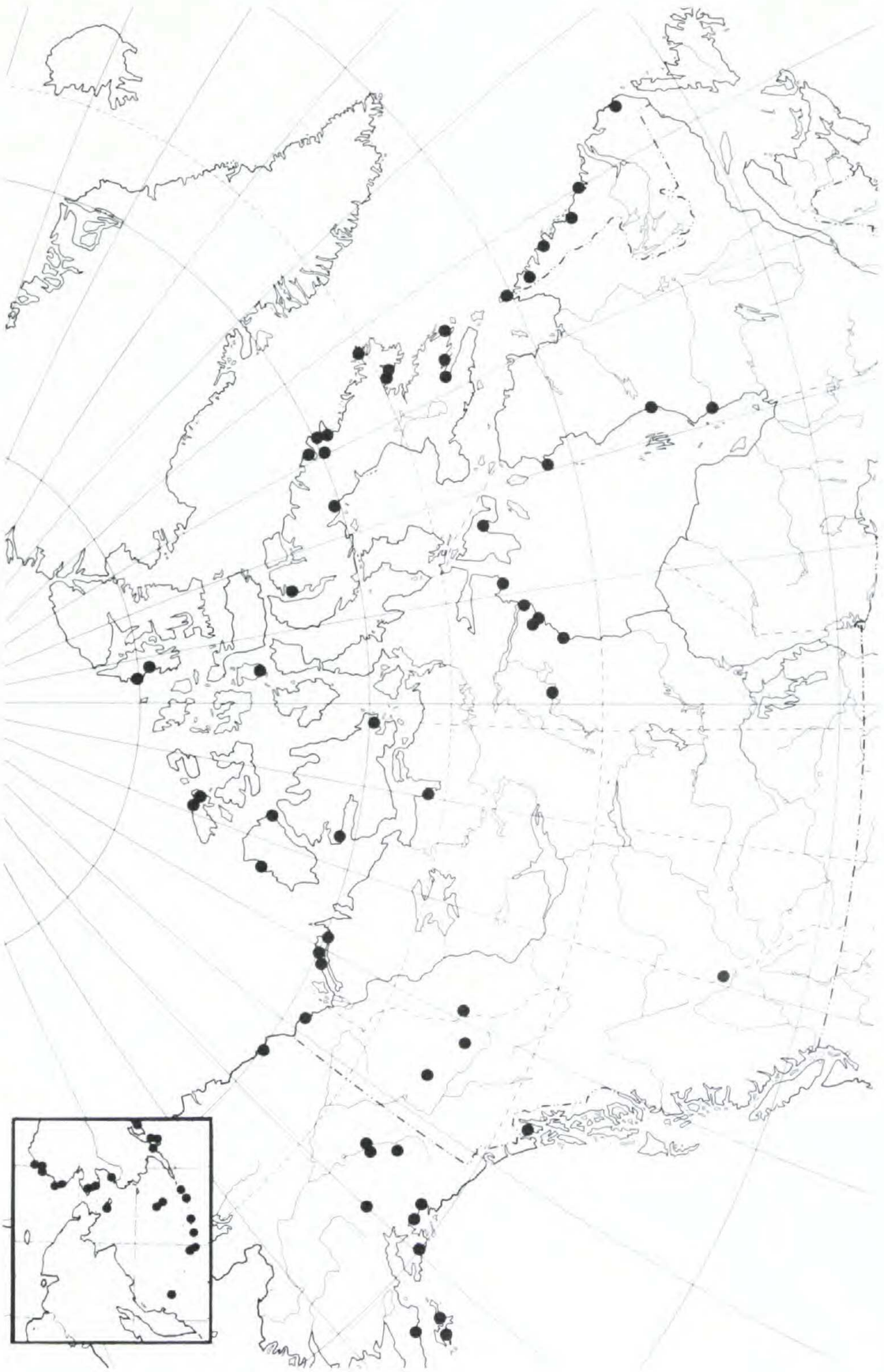

Figure 15. Geographical distribution of *Sagina nivalis* in North America.

linear, lower leaves 4–15 mm long, becoming shorter toward the apex, upper leaves 2.5–6.0 mm long. Leaf margins entire, rarely with minute glandular cilia. Leaves apiculate to aristate. Connate leaf bases not conspicuous, never forming an inflated cup. Pedicels generally long, filiform, recurved during capsule development, becoming erect at maturity. Flowers 4-merous, occasionally 4- and 5-merous. Pedicels long, filiform. Sepals elliptical to orbicular, 1.5–2.0 (–2.5) mm long, hyaline margins white, never purple tinged. Petals equal to or fewer than number of sepals, sometimes absent; 0.75–1.0 (–1.5) mm long, orbicular to elliptical. Stamens 4, occasionally 8, filaments 1.0–1.5 mm long, anthers 0.25 mm long. Capsules slightly exceeding sepals. Capsule valves thin, (1.5–) 2.0–2.5 (–3.0) mm long. Sepals appressed during capsular development, divergent following dehiscence. Seeds brown, obliquely triangular, with a distinct dorsal groove, (0.3–) 0.4 (–0.5) mm long. Chromosome number: $2n = 22$. Figure 11.

ECOLOGY AND DISTRIBUTION: A weedy species, growing in wet or damp gravelly or sandy soils along roadsides, sidewalk cracks, and margins of paths or lawns. Also frequent along pond and lake margins, coastal rocks and sands and sea cliffs. The species is sometimes cultivated as a ground cover. In eastern North America from Newfoundland, west to New York and eastern Pennsylvania, and the southwest shore of Lake Superior. In western North America, from the San Francisco area north to Washington and infrequently northward to the Queen Charlotte and Aleutian Islands. Single collections are known from Detroit, Michigan; Columbus, Ohio; Pulaski Co., Arkansas; Missouri (no specific locality cited); and Marysvale, Utah. Occasionally at high elevations in Mexico and Central America. Also introduced in eastern Asia and the Southern Hemisphere. Native to Eurasia. Flowering May to September. Figure 12.

REPRESENTATIVE SPECIMENS: **Canada.** BRITISH COLUMBIA: Between Prince Rupert and Galloway Rapids, *Calder, Savile & Ferguson 13208* (DAO). Near east end of Summit Lake on road from Nakusp to New Denver, *Calder & Savile 10010* (DAO, NY). Vancouver, *Eastham 9906* (UC). New Westminster, *Henry 9139* (RM). Hecate Island, *McCabe 7134* (UC). East shore of Kootnay Lake, 15 mi. south of Boswell, *Senn & Frankton 5868* (DAO). Queen Charlotte Islands, Summit, between Gillatt Arm of Cumshewa Inlet and Peel Inlet, Moresby Island, *Calder & Taylor 35173* (DAO). Vancouver Island, Duncans-Cowichan Lake road, *Rosendahl 1758* (GH, NY, UC, US). NEW BRUNSWICK: Charlotte Co., Mill Cove, Campobello Island, *Malte*

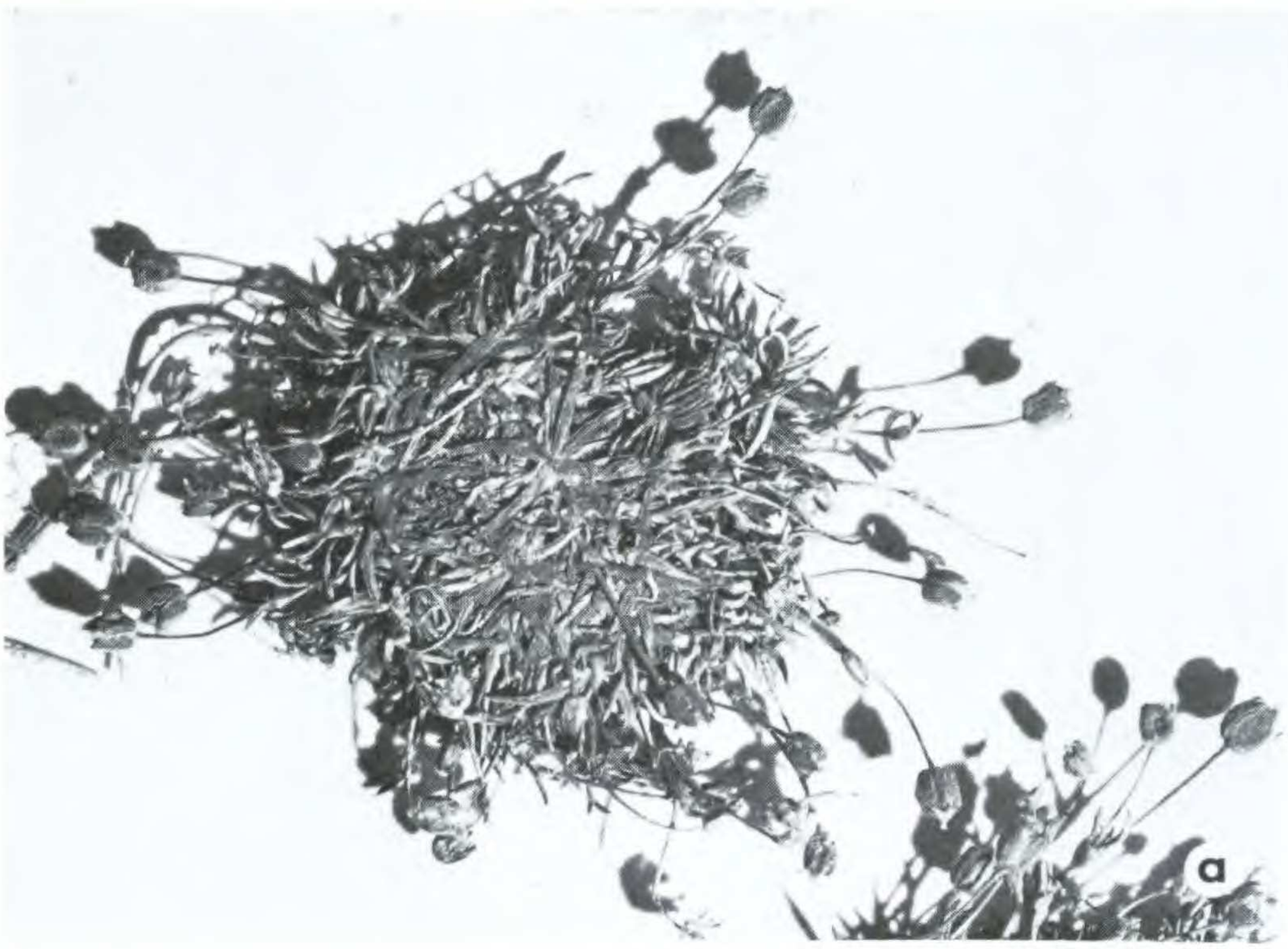

Figure 16. *Sagina caespitosa*. a. habit; b. close-up showing pubescence on calyx base and pedicel. Both Baralzon Lake, Manitoba (*Scoggan & Baldwin 8206*, CAN).

971/29 (CAN, GH). Gloucester Co., Grande Anse, *Blake 5533* (CAS, GH, NY, US, WTU). Kent Co., Bass River, *Fowler s.n.*, August 1875 (WIS). Kings Co., Sussex, *Svenson & Fassett 2000* (GH). Northumberland Co., Little Branch, Miramichi, *Fowler s.n.*, 24 August 1894 (F, US, WIS). Restigouche Co., Eel River, near Dalhousie, *Malte 456* (CAN). Sunbury Co., Oromocho River at Fredericton Junction, *Roberts & Bateman 64–2069* (DAO). Westmorland Co., about 15 mi. northeast of Sackville, *Scoggan 12243* (CAN). York Co., Fredericton, *Scoggan 11867* (CAN). LABRADOR: Perquet Island, 51°26′N., *Allen 66* (GH, NY). Red Islands, near Turnavik, 53°48′N., 56°46′W., *Bishop 285* (CAN, US). Forteau, on Strait of Belle Isle, *Donly s.n.*, ca. 20 August 1964 (DAO). NEWFOUNDLAND: Gander, *Bassett 483* (DAO, MO). Birchy Cove, Curling, Bay of Islands, *Fernald & Wiegand 3334* (CAN, GH, NY). Cow Head, north of St. Paul's Bay, *Fernald & Wiegand 3335* (GH). Dildo Run, southern shores of Notre Dame Bay, *Fernald & Wiegand 5378* (F, GH, MO). Grand Bruit, district of Burgeo and La Poile, *Fernald, Long & Fogg 247* (GH). Port Saunders, region of Ingorachoix Bay, *Fernald & Wiegand 3336* (GH). Ship Cove, Sacred Bay, *Fernald, Wiegand & Long 28152* (GH). Tilt Cove, northern shores of Notre Dame Bay, *Fernald & Wiegand 5379* (NY, RM, UC). Bell Island, near Topsail, Conception Bay, *Howe & Long 1308* (NY). St. John's, *Robinson & Schrenk 218* (CAN, DAO, F, GH, MIN, MO, NY, US). Hughes Brook, Humber District, *Rouleau 1662* (CAN, DAO, NY, US). Fogo Island, *Sornborger s.n.*, 7 August 1903 (CAN, GH, NY, US). NOVA SCOTIA: Cape Breton Co., Sydney, Cape Breton Island, *Barnhart 832* (NY). Colchester Co., Lynn, *Dore 45.1095* (DAO). Cumberland Co., cliffs near Moose River, about 8 mi. east of Parrsboro, *Scoggan 13820* (CAN). Digby Co., Brier Island, *Smith, Roland, Collins, Erskine & Schofield 126* (DAO). Guysborough Co., Boyleston, *Hamilton 18294* (CAN, US). Halifax Co., Halibut Cove, near Halifax, *Dore, Senn & Gorham 45.521* (DAO). Inverness Co., near Pleasant Bay, Cape Breton Island, *Pease 26634* (GH). Kings Co., Hall Harbor, *Fassett 19049* (WIS). Lunenburg Co., Chester, *Pease 26655* (GH). Pictou Co., Pictou, *Robinson 209* (NY). Shelburne Co., on the island, Barrington Passage, *Macoun 80869* (CAN, MO). Victoria Co., Money Rocks, St. Paul Island, *Perry & Roscoe 194* (CAN, GH, MO, NY, US). Yarmouth Co., Jassy Lake, Lake Annis, *Bean, White & Linden 21193* (GH, NY, US). Sable Island, 43°59′N., 59°47′W., *St. John 1226* (CAN, GH, NY, US). PRINCE EDWARD ISLAND: Near Bonshaw, *Erskine & Dore 1105* (DAO, NY). QUEBEC: Anticosti Island Co., Pointe de l'est, *Marie-Victorin, Rolland-Germain & Louis-Marie 21 642* (GH). Bonaventure Co., Port Daniel, *Lepage 13542* (DAO). Brome Co., Bolton Pass, *Marie-Victorin, Rolland-Germain, Raymond & Rouleau 56363* (GH). Gaspé-Est Co., Perce, *Marie-Victorin & Rolland-Germain 49 462* (DAO, MICH). Levis Co., Point Garneau, *Cing-Mars & Cayouette s.n.*, 15 September 1954 (DAO). Magdaline Islands Co., Grindstone, Grindstone Island, *Fernald, Bartram, Long & St. John 7439* (GH). Matane Co., Riviere Blanche, *Forbes 1494* (CAN, DS, GH). Rimouski Co., Cap a'l'Original, Bic, *Clausen & Trapido 2827* (MIN, UC). Riviere-De-Loup Co., Trois-Pistoles, *Lepage 15325* (DAO). Saguenay Co., Blanc Sablon, Straits of Belle Isle, *Fernald, Wiegand & Long 28156* (GH). Temiscouata Co., Saint-Hongré, *Blouin, Carrier, Lemiaux & Richard 7373* (DAO). Wolfe Co., Notre-Dame de Ham, Canton d'Ham Nord, *Hamel & Brisson 15399* (CAN). **France.** ILES SAINT-PIERRE: Savoyard, *Le Hors s.n.*, 16 August 1950 (DAO).

Mexico. FEDERAL: Llano do la Cieneguilla, cerca del Cerro de la Palma, Sierra de las Cruces, elev. 3500 m, *Rzedowski 23849* (ENCB); 3 km al SW de Ajusco, elev. 3050 m, *Cruz Cisneros 1343* (ENCB); Puerto de Las Cruces, delagación de Cuaji-

malpa, elev. 3000 m, *Rzedowski 30804* (ENCB); Cerca del Puerto de Las Cruces, Sierra de Las Cruces, elev. 3000 m. *Rzedowski 21733* (ENCB). HIDALGO: Cerro de las Ventanas, 6 km al N de Pachuca, elev. 2900 m, *Rzedowski 28003* (ENCB). MEXICO: Vertiente NW del Ixtaccíhuatl, en la región de Peñas Cuatas, La Ciénega, *Rzedowski 21813* (ENCB, MICH); Vertiente SW del Ixtaccíhuatl, La Joya, elev. 3850 m, *Rzedowski 21813* (ENCB, MICH); Cerca del Paso de Cortés, entre Popocatépetl e Ixtaccíhuatl, elev. 3550 m, *Rzedowski 21847* (ENCB); Canón al E de Santiago Cuautenco, municipio de Amecameca, elev. 2650 m, *Rzedowski 26711a* (ENCB).

United States. ALASKA: Haines (Chilkoot Inlet, Lynn Canal, N of Juneau), *Anderson 6047* (CAN). Unalaska (Aleutian Islands), *Eyerdam 2273* (CAN, CAS, DS, NY, UC, US). Girdwood (Cook Inlet, Turnagain Arm, SE of Anchorage), *Hultén s.n.*, 1 July 1961 (US). Sand Point, Shumagin Islands, *Riggs s.n.*, 31 July 1913 (US). Vicinity of Massacre Bay, Peaceful Valley, Attu Island (Aleutian Islands), *Van-Schaack 499a* (US). ARKANSAS: Pulaski Co., without definite locality, *Hasse s.n.*, May 1886 (MONTU). CALIFORNIA: Amanda Co., weed in University of California Botanical Garden, Berkeley, *Crow 1179* (MSC, NHA). Del Norte Co., along road in redwoods north of Crescent City, *Eastwood 12299* (CAS). Humboldt Co., Freshwater Creek near Wrangletown, *Tracy 5338* (CAS, UC, WTU). Marin Co., Shell Beach, *Howell 20929* (CAS). Mendocino Co., Highway 1, Caspar, *Nobs & Smith 1149* (CAS). San Francisco Co., Golden Gate Park on cross park boulevard, San Francisco, *Howell 32571* (CAS, MSC). San Mateo Co., ravine north of Seal Cove, *Dudley s.n.*, 16 March 1900 (DS). Santa Clara Co., weed in Stanford Experimental Garden, Stanford University, Stanford, *Thomas 8725* (DS). CONNECTICUT: Fairfield Co., Fairfield, *Johnson s.n.*, 30 June 1890 (NY). Hartford Co., South Glastonbury, *Wilson 75* (RM). Litchfield Co., Norfolk, *Redfield 13062* (MO). New Haven Co., Milford, *Eames 1494* (MIN). New London Co., Franklin, *Woodward s.n.*, 30 August 1914 (GH). Tolland Co., Hop River, Andover, *Seymour 17643* (WIS). Windham Co., Connecticut River, Westminster, *Blanchard 70* (GH). DELAWARE: New Castle Co., Wilmington, *Tatnall s.n.*, 21 May 1930 (GH). IDAHO: Kootenai Co., Hayden Lake, *Baker 14882* (WTU). MAINE: Cumberland Co., Portland, *Garber s.n.*, 29 August 1874 (F). Franklin Co., South Chesterville, *Eaton 17001* (WIS). Hancock Co., vicinity of Blue Hill, *Maxon 11036* (US). Kennebec Co., South Litchfield, *Fassett 18292* (WIS). Knox Co., Union, *Cole 973* (US). Lincoln Co., Ocean Point, *Fassett 15442* (WIS). Sagadahoc Co., Bowdoinham, *Fassett 2850* (WIS). York Co., South Berwick, *True 1141* (US). Washington Co., *Cutler, Kennedy, Williams, Collins & Fernald s.n.*, 2 July 1902 (GH). MARYLAND: Baltimore Co., Baltimore, *Jones s.n.*, 25 May 1904 (F). MASSACHUSETTS: Barnstable Co., Woods Hole, *Bacon 95* (MSC). Berkshire Co., Great Barrington, *Leavenworth s.n.*, in 1820 (MSC). Bristol Co., New Bedford, *Greene s.n.*, date unknown (WIS). Dukes Co., Gay Head, Martha's Vineyard, *Seymour 1201* (GH, NY, US). Essex Co., Newburyport, *Fernald s.n.*, 2 October 1902 (GH). Franklin Co., Charlemont, *Hunnewell 10659* (GH). Hampden Co., Granville, *Seymour 121* (GH, MO). Hampshire Co., Huntington, *Robinson 776* (GH). Middlesex Co., Waltham, *Seymour & Seymour s.n.*, 4 July 1911 (CAS, MSC, WIS). Nantucket Co., Brant Point Road, Nantucket Island, *Bicknell s.n.*, 20 June 1908 (NY). Plymouth Co., Middleboro, *Murdoch 596* (F). Suffolk Co., Revere, *Clark s.n.*, in 1873 (MSC). Worcester Co., Lancaster, *Seymour s.n.*, 5 July 1944 (WIS). MICHIGAN: Houghton Co., Otter Lake, *Hyypio 409* (MSC). Keweenaw Co., Allouez, *Hermann 7797* (DS, F, MICH, MO, NY, US, WS). Marquette Co., Champion, *Hill s.n.*,

10 July 1889 (GH, NY). Wayne Co., golf links, Detroit, *Piper s.n.* 8 June 1922 (US). MINNESOTA: St. Louis Co., Duluth, *Lakela 2561* (MIN, NY, UC, WS). MONTANA: Lincoln Co., Stanley Creek, base of Stanley Mt., elev. 760 m, *Harvey 5492* (MONTU). NEW HAMPSHIRE: Carroll Co., Wakefield, *Sargent s.n.*, 2 August 1912 (NHA). Cheshire Co., Hinsdale, *Batchelder 5305* (NHA); Walpole, *Eaton & Griscom 17163* (NHA). Grafton Co., road near confluence of Batchelders Brook and Bakers River, Warren, *Churchill s.n.*, 11 July 1939 (MSC). Hillsborough Co., Peterborough, *Batchelder s.n.*, 3 September 1928 (MO). Rockingham Co., Isle of Shoals, *Canby s.n.*, August 1866 (WS); Windham, *Harris 436* (NHA). Strafford Co., banks of Bellamy River, Madbury, *Moulton & Hodgdon 9047* (NHA). NEW JERSEY: Ocean Co., Beach Haven Terrace, Long Beach Island, *Long 3798* (GH). Passaic Co., Hewitt, *Mackenzie 2850* (MO). NEW YORK: Albany Co., Albany, *House 28498* (NY). Bronx Co., Bronx, *Moldenke 20157* (CAN). Franklin Co., Adirondack Hatchery, Saranac Inn, *Muenscher & Maguire 113* (F, MO). Fulton Co., Nick Stone Golf Course, Caroga Lake, *Fassett 10374* (WIS). Onadaga Co., near Jamesville, *House s.n.*, 1 August 1903 (NY). Oneida Co., Utica, *Harberer 129* (GH, NY). Rensselaer Co., Troy, *Hall s.n.*, 1828–1834 (F). Richmond Co., Richmond Valley, Staten Island, *E. G. Britton s.n.*, 24 June 1894 (GH, NY). Rockland Co., Clarkestown Twp., *Lehr 1020* (NY). Saratoga Co., Satatoga Springs, *House 27928* (GH, NY). Suffolk Co., Wading River, Long Island, *Miller 327* (UC). Tompkins Co., Ithaca, *Eames 9870* (GH, MO). Westchester Co., Tarrytown, *Barnhart 1446* (NY). OHIO: Pickaway Co., Tarlton, *Bartley 1526* (NY, US). OREGON: Clatsop Co., Cannon Beach, *Thompson 12746* (MO, NY, WS, WTU). Coos Co., Fossil Point, Coos Bay, *Abrams & Benson 10577* (DS). Curry Co., The Heads, Port Orford, *Peck 9062* (GH, MO, NY). Klamath Co., north end of Lake-of-the-Woods, *Peck 16598* (DS). Land Co., just south of Heceta Head lighthouse, *Cronquist 6112* (GH, NY, UC, WTU). Lincoln Co., Yachats, *Cooke 10717* (OSC). Multnomah Co., Albina, *Suksdorf 1744* (WS). Tillamook Co., Garibaldi, *Erickson s.n.*, 15 July 1954 (OSC). PENNSYLVANIA: Berks Co., Reading, *Fisher s.n.*, 23 August 1905 (MICH). Cumberland Co., Newville, *Wahl, Wherry, Hammond, Stafford & Tanger 6624* (GH). Lackawana Co., Scranton, *Glowenke 6861* (GH). Lehigh Co., Allentown, *Schaeffer 56239* (US). Monroe Co., Pocono Manor, *Wherry s.n.*, 18 June 1945 (DAO). Montgomery Co., Philadelphia, *Witte s.n.*, 7 July 1934 (RM, NY). RHODE ISLAND: Newport Co., Newport, *Tweedy s.n.*, June 1881 (DS). Providence Co., Providence, *Collins s.n.*, 30 May 1891 (US). Washington Co., Block Island, *Watson s.n.*, June 1885 (GH). UTAH: Piute Co., Tate Mine, Marysvale, elev. 9000 ft., *Jones 5855* (MO). VERMONT: Caldonia Co., Groton, *Seymour 18328* (WIS). Orange Co., Newbury, *Jesup & Sargent s.n.*, 29 July 1891 (GH). Washington Co., Walden and Cabot, *Burbank, Grout & Eggleston s.n.*, 4 July 1894 (NY). Windham Co., Newfane, *Grout s.n.*, 2 July 1895 (F). Windsor Co., Rochester, *Dutton s.n.*, 10 July 1914 (GH, MICH, MO). WASHINGTON: Clallam Co., Elcoha River, Olympic Peninsula, *Jones 3522* (WTU). Chelan Co., head of Poison Creek, north side of Lake Chelan, *Ward 700* (CAS, WS, WTU). Clatsop Co., Cornet Bay, Whidbey Island, *Smith 1720* (UC). King Co., Kirkland Lake, *Eyerdam 1686* (DAO). Kittitas Co., Snoqualmie Pass, *Wiegand 840* (F). Kitsap Co., Colby, *Warren 276* (WS, WTU). Klickitat Co., Bingen, *Suksdorf 5013* (WS). Pacific Co., Ilwaco, *Abrams 11272* (DS). San Juan Co., Long Island, *Muenscher & Muenscher 15979* (MIN). Skagit Co., Bear Creek, T36N, R8E, sec. 10, Mt. Baker National Forest, *Crow 1241* (MSC, NHA). Snohomish Co., Everett, *Minch s.n.*, 23 July 1928 (WS). Wahkiakum Co., Cathlamet, *Foster s.n.*, 10 May 1907

(WS). Whatcom Co., Little Sandy Creek, Baker Lake, T37N, R8E, sec. 12, *Crow 1238* (MSC, NHA). WISCONSIN: Iron Co., Hurley, *Fassett 9541* (WIS).

Typification of *Sagina procumbens* presents a difficult problem which I have discussed at length with W. T. Stearn of the British Museum (Natural History). Using the diagnostic phrase *ramis procumbentibus,* Linnaeus (1737a), placed his *Sagina procumbens* in "Octandria Tetragynia" in his *Flora Lapponica* and clearly intended the name to apply to a Lapland plant with flowers parts in fours and procumbent shoots. In *Species Plantarum* Linnaeus (1753) utilized the same phrase name, unaltered from *Flora Lapponica,* but placed *S. procumbens* in "Tetrandria Tetragynia" and recognized two additional varieties. This suggests that his concept of the species at the time of the writing of *Species Plantarum* was based on material he had seen since writing *Flora Lapponica.* I have studied the specimen labelled *Sagina procumbens* in the Linnaean Herbarium at the Linnean Society of London, LINN *177.1.* It is clearly *S. subulata* (a pentamerous species), as annotated by Smith. A specimen supposedly representing Linnaeus' *Flora Lapponica* no. 157 is in the Linnaean Lapland herbarium at the Institute de France, Paris. In an account of this herbarium by Th. M. Fries (1861), it is stated that the specimen representing *Flora Lapponica* no. 157 was not the accepted *S. procumbens* but was *S. saxatilis* Wimmer (now considered conspecific with *S. saginoides*), a pentamerous taxon. I have studied a photograph of this specimen and agree it cannot be taken to represent Linnaeus' concept of *S. procumbens.* In the absence of a *S. procumbens* specimen which can be indubitably accepted as the type I choose to allow Linnaeus' protologue to represent the name.

A few specimens from the coast of Labrador and of the St. Lawrence seaway have been considered as *Sagina procumbens* var. *compacta* Lange. These plants appear to be depauperate, environmentally induced growth forms. Dr. J. K. Morton (personal communication, 1973) has also questioned the validity of this taxon. His field observations in a dune situation indicate that there seemed to be a cline from the very compact form ("good" var. *compacta*) growing away from the shore and becoming more normal toward the shore. Morton collected seed and vouchers from both extremes and grew the plants under cool greenhouse conditions. Because plants grown from the compact form appear as normal *S. procum-*

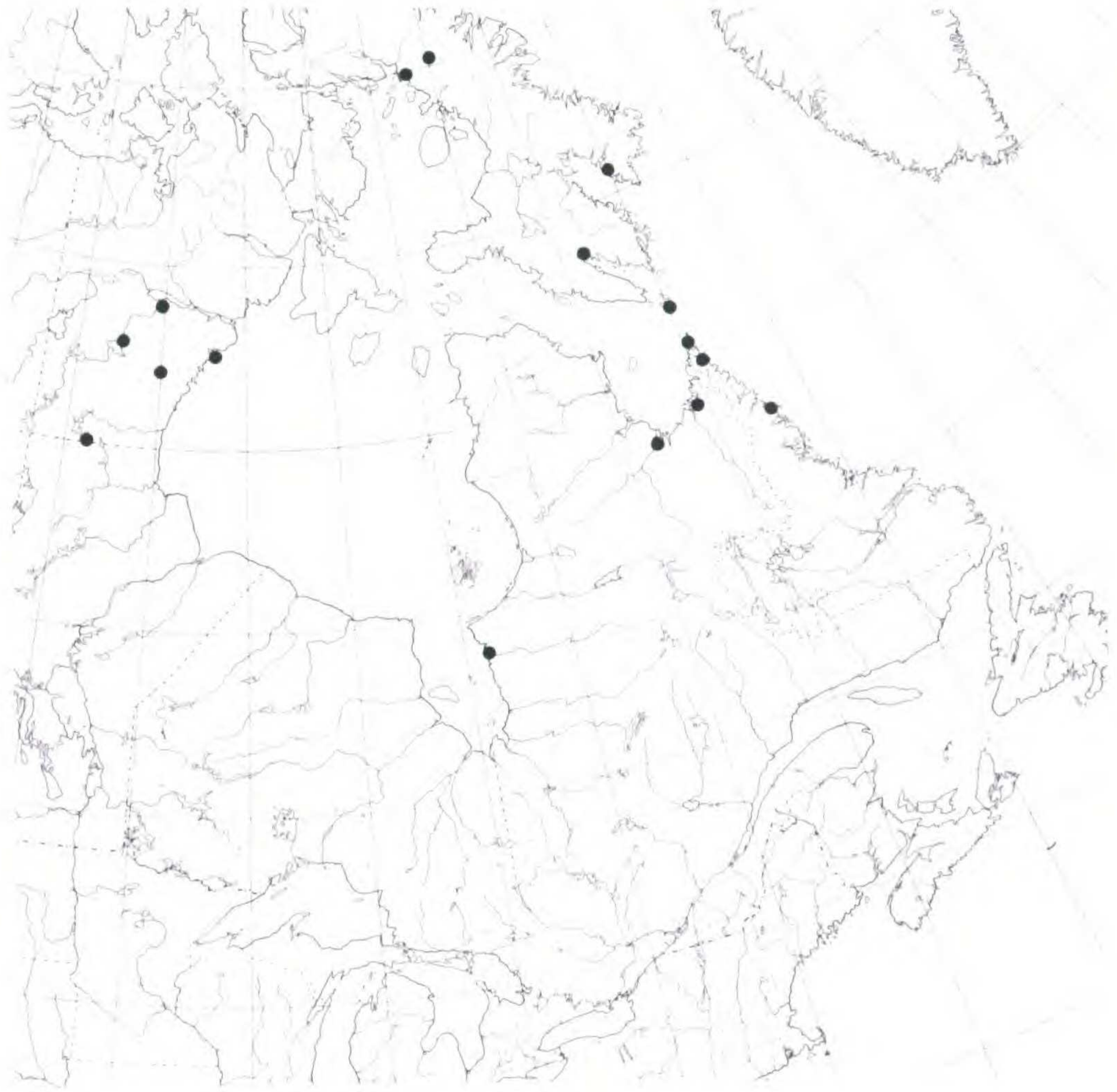

Figure 17. Geographical distribution of *Sagina caespitosa* in North America.

bens, we agree that var. *compacta* should be considered no more than a growth form.

I have studied J. Vahl's specimens of *Sagina procumbens* from Greenland on deposit at Copenhagen (C) and none of these can be taken as type material. The two specimens labelled Igaliko, Greenland, the type locality, do not fit Lange's concept of var. *compacta.*

4. **Sagina subulata** (Sw.) Presl, Fl. Sic. 158. 1826.

Spergula subulata Sw., Sven. Vet. Acad. Handl. Stockh. p. 45. 1789. *Phaloe*

subulata (Sw.) Dumort., Fl. Belgica p. 110. 1827. *Spergella subulata* (Sw.) Reichb., Fl. Germ. Excurs. p. 794. 1832. *Alsine subulata* (Sw.) Krause, in Sturms, Fl. Deutschl. 2 ed. **5:** 34. 1901. TYPE: "Halland, Doct. Osbeck". (Lectotype, BM!)

Sagina revelieria Jord. & Fourr., Brev. Pl. Nov. fasc. i. p. 11. 1866. TYPE: not seen. ORIGINAL MATERIAL: Corsica Mountains, Quenza, Corsica, France.

Perennial. Plants tufted, caespitose, frequently forming dense mats. Horizontal stems becoming slightly woody with extensive mat formation. Branches short, with short internodes, ascending or decumbent, often not exceeding basal leaves. Stems densely glandular pubescent or less frequently glabrous. Leaves densely glandular pubescent or with glandular hairs restricted to the margins, and then often minutely glandular ciliate, rarely glabrous. Leaves with long aristae, 0.5–0.75 mm long. Basal tufts of leaves linear, 3.0–12 mm long, curled inward. Cauline leaves linear-subulate, 3.0–10 mm long. Connate leaf bases scarious, forming a conspicuous cup. Flowers axillary or terminal, usually solitary. Pedicels long, filiform, mean length 22.5 mm, erect during capsular development. Pedicels densely to weakly pubescent. Flowers 5-merous, rarely 4- and 5-merous. Sepals elliptical, 1.5–2.0 mm long, the hyaline margins white. Petals elliptical, 1.5–2.0 mm long, shorter than or equaling sepals. Stamens 10, filaments (1.0–) 1.5 mm long, anthers 0.25 mm long. Capsules slightly exceeding sepals. Capsule valves thin, 2.0–3.0 (–3.5) mm long, dehiscing to base. Sepals remaining appressed following capsule dehiscence. Seeds brown, obliquely triangular, with dorsal groove, a distinct notch at hilum, surface smooth, 0.4 (–0.5) mm long. Chromosome number: $2n = 18, 22$. Figure 13.

ECOLOGY AND DISTRIBUTION: In wet gravelly sands of stream margins. Introduced from Europe and known only from Harney Co., Oregon, Bedford Co., Virginia and La Laguna, Baja California.

Flowering June to August.

REPRESENTATIVE SPECIMENS: **Mexico.** BAJA CALIFORNIA: Sierra de la Laguna, *Brandegee s.n.*, 22 January 1890 (UC). Sierra de la Laguna, *Brandegee s.n.*, 27 March 1892 (GH, UC). Sierra de la Laguna, *Brandegee s.n.*, 4 October 1899 (GH, NY, UC). Cape Region, La Laguna, elev. 6000 ft., *Thomas 7885* (CAS, DS, GH, MICH, US).

United States. OREGON: Harney Co., Steens Mt., *Faegri s.n.*, 25 July 1965 (OSC); Dino Creek, Steens Mt., *Train s.n.*, 30 July 1935 (US) and 31 July 1935 (MIN). VIRGINIA: Bedford Co., specific locality unknown, *Curtiss s.n.*, 20 May 1872 (MO).

Figure 18. *Sagina decumbens* ssp. *decumbens*. a. habit; b. close-up showing glandular pubescence. Both South Carolina (*Weatherby & Griscom 16524*, US).

Sagina subulata is an extremely variable, wide ranging European species. *Sagina glabra* and *S. pilifera,* two closely allied European montane taxa of restricted distribution, overlap in numerous characteristics with *S. subulata* and appear to be divergent expressions of this variable species. Further study of these taxa may reveal that this complex should be considered a single species with three infraspecific taxa.

I have seen a single specimen from eastern North America which is referable to *Sagina subulata.* Plants treated by Torrey and Gray as *S. subulata* belong to *S. decumbens* ssp. *decumbens* (see discussion under that taxon).

In the Northwest, three specimens (*Train s.n.,* July 30, 1935 and July 31, 1935; *Faegri s.n.,* July 25, 1965) collected in the alpine zone of Steens Mt., Harney Co., Oregon exhibit glandular pubescence. The Train specimens are extremely pubescent while the Faegri specimen is weakly glandular, with foliar pubescence restricted to leaf margins. Introduction of this population of *Sagina subulata* into this remote area is without explanation.

Another isolated population of *Sagina subulata* occurs at the tip of Baja California. Specimens collected by T. S. Brandegee during the period 1890–1899 and by J. H. Thomas in 1959 in the mountains at La Laguna (ca. 5,500 ft. elevation) occurred in the region of an abandoned ranch which had been operated in the 1800's (Goldman, 1951). Introduction of this population probably took place when the ranch was functioning.

A mat-producing form of this taxon is widely used as a ground cover and is available from nurserymen under the names "Scottish Moss" and "Corsican Pearlwort." Living plants observed in the W. J. Beal Botanical Garden, Michigan State University, were noted to flower profusely but with no subsequent capsular development; and herbarium specimens from several localities in the western United States show little capsular development. The cultivar propagates easily by vegetative means, but is not found readily escaping cultivation. The cultivar differs from the native European mat-producing form by being glabrous, except for the minutely glandular-ciliate leaf margins. The cultivated form originated in the Corse Mountains, Corsica, France (Vilmorin, 1894).

5. **Sagina nivalis** (Lindbl.) Fries, Nov. Fl. Suec. Mant. **3:** 31. 1842.

Spergula saginoides var. *nivalis* Lindbl., in Physiogr. Sällsk. Tidskr. p. 328. 1838.

TYPE: not seen. ORIGINAL MATERIAL: region of Kongsvold near Doores, Norway, 24 September 1837.

Sagina intermedia Fenzl, in Ledeb., Fl. Ross. **1:** 339. 1842. *Spergella intermedia* (Fenzl) Lõve & Löve, Bot. Notiser 128: 508. 1975. TYPE: Unknown. ORIGINAL MATERIAL: region of Tschuktschorum along bays of St. Laurent, Russia.

Perennial. Caespitose, forming low cushions. Basal rosette of succulent, subulate leaves, tips apiculate. Flowering stems numerous, radiating from axils of basal rosette leaves. Stems slender, sometimes purple tinged. Cauline leaves subulate, with connate leaf bases forming shallow scarious cup, often purplish, becoming shorter toward stem apex. Pedicels long, filiform, glabrous. Flowers 4-merous or 4- and 5-merous. Sepals 1.5–2.0 mm long, nearly orbicular to elliptical, rounded at tip, glabrous, frequently purplish, hyaline margins nearly always purple, sometimes only at tip. Petals equaling to slightly shorter than sepals, 1.5–2.0 mm long. Stamens 8 or 10, filaments 1.5 mm long, anthers 0.25 mm long. Capsules 4- or 5-valved, 2.0–3.0 mm long, dehiscing to base. Capsule valves thick. Sepals remaining appressed following capsule dehiscence. Seeds brown, obliquely triangular, with dorsal groove, distinctly notched at hilum, lateral surfaces frequently with elongate ridges, dorsal surface appearing smooth to pebbled, 0.5 mm long. Chromosome number: $2n = 84, 88$. Figure 14.

ECOLOGY AND DISTRIBUTION: Growing on sandy or gravelly beaches, coastal rocks, alluvial plains, fresh glacial moraines and low, swampy tundra and in alpine areas. Widely distributed in the Arctic Archipelago, Alaska, Hudson-James Bay region and the coast of Labrador. Disjunct population in Alberta. Flowering July and August. Figure 15.

REPRESENTATIVE SPECIMENS: **Canada.** ALBERTA: Medicine Lake, Jasper National Park, *Scamman 2527* (GH). Mt. Edith Cavell, Angel Glacier, Jasper National Park, *Scamman 2446* (GH), mixed collection. LABRADOR: Chateau, 51°49′N. *Allen s.n.*, 8 August 1882 (F, NY). Nunaksuk Island, *Bishop 285b* (GH). Crater Lake vicinity, ca. 52 mi. west southwest of Hebron, 58°02′N., 64°02′W., *Gillett 8938* (DAO, US). Makkovik, 55°N., *Hustick 68* (CAN). Cutthroat Harbour, south of Cape Mugford, 57°30′N., 62°W., *Porsild 189* (CAN). Battle Harbour, *Waghorne 4901* (CAN). Okkak, near Cutthroat Tickle, 57°40′N., 62°W., *Wynn-Edwards 7476* (CAN). NORTHWEST TERRITORIES: District of Franklin, Northwest Middle Fiord, Axel Heiberg Island, *Beschel 13118* (CAN). Mould Bay, Prince Patrick Island, 76°14′N., 118°59′W., *Bruggemann 361* (DAO, NY, UC). Frobisher Bay, Baffin Island, 63°45′N., 68°32′W., *Calder 2085* (DAO, US). Erik Harbour, Baffin Island, 72°40′N., 76°30′W., *Coombs 31* (DAO). Head of Inugsuin Fiord, Baffin Island, *Hainault 3634* (CAN). Ferguson

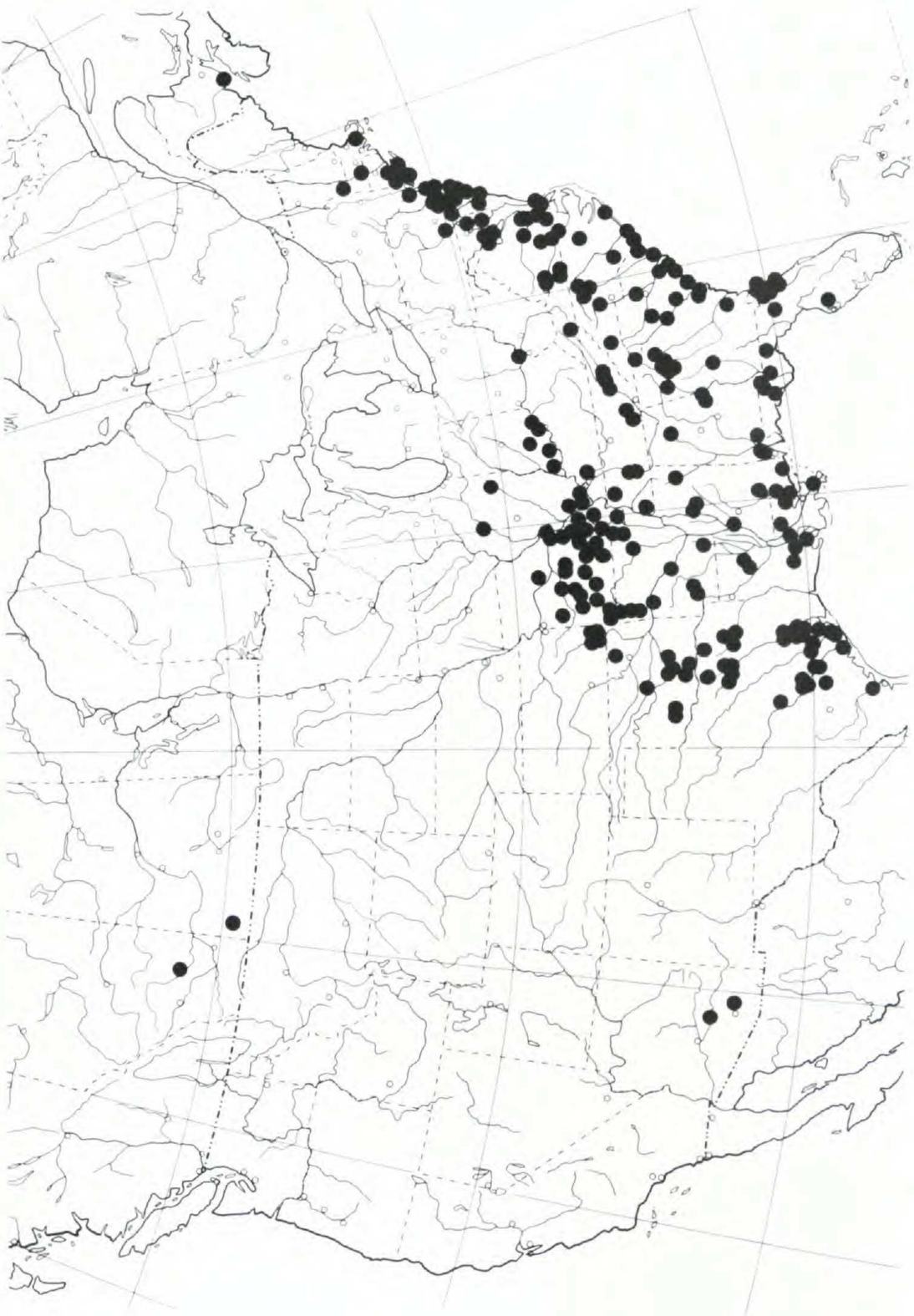

Figure 19. Geographical distribution of *Sagina decumbens* ssp. *decumbens*.

Lake, Victoria Island, 69°25′N., 105°15′W., *Jones 29a* (DAO). Pangnirtung, Baffin Island, *Polunin 1168* (US). Arctic Bay, Baffin Island, *Polunin 2555* (CAN). Banks Island, near northeast corner, ca. 73°24′N., 117°W., *Porsild 17677* (CAN). Bernard Island on northwest coast of Banks Island, *Porsild 17747* (CAN). Resolute Bay, Cornwallis Island, *Porsild 21672* (CAN). Head of Minto Inlet, Victoria Island, *Porsild 17388* (CAN). Botany Bay, Kangerdluak Fiord, Ekalugad Fiord region, Baffin Island, *Webber 1302* (CAN). Cape Searle, Padloping, ca. 67°10′N., 62°30′W., *Wynne-Edwards 9147* (CAN). District of Keewatin, Cape Jones, *Baldwin, Hustich, Kucyniak & Tuomikoski 664* (CAN). Smith Island, east coast of Hudson Bay, *Baldwin 1824* (CAN, GH). Coral Harbour, South Hampton Island, *Calder, Savile & Kukkonen 24228* (DAO). Fullerton, Hudson Bay, 63°57′N., *Macoun 79091* (CAN, GH). Port Burwell, Hudson Strait, 60°22′N., 64°54′W., *Malte s.n.*, 25–28 July 1928 (CAN, GH). Mistake Bay, 62°05N., 93°06W., *Prosild 5664* (CAN). Yathkyed or Hikolikdjuak Lake on the Kazan River, 62°30′–63°N., 97°–98°30′W., *Porsild 5795* (CAN). Chesterfield Inlet, 1 mi. north of settlement, 63°21′N., 90°42′W., *Savile & Watts 1266* (DAO, MO, WTU). District of Mackenzie, O'Grady Lake, Mackenzie Mts., 63°00′N., 129°02′W., *Cody 16416* (DAO). Bathurst Inlet, west side, *Keisall & McEwen 190* (CAN). Cape Dalhousie, Arctic Coast, ca. 70°20′N., 129°55′W., *Porsild & Porsild 2747* (CAN). Shingle Point, Arctic Coast, ca. 69°N., 137°30′W., *Porsild 7099* (CAN). QUEBEC: Richmond Gulf, Cairn Island, east coast of Hudson Bay, ca. 56°15′N., 76°30′W., *Abbe, Abbe & Marr 4399* (MIN). Stromness Harbor, Fort George, James Bay, 53°56′N., *Dutilly & Lepage 12740* (GH). YUKON TERRITORY: Mayo Landing, *Broadfoot 5* (DAO). Canol Rd., Mile 95, upper Rose River valley, *Porsild & Breitung 10368* (CAN).

United States: ALASKA: Mendenhall, *Anderson 434* (NY). Wainwright, *Anderson 4364* (UC). Snow River delta, Kenai Lake, Kenai Peninsula, 60°19′N., 149°21′W., *Calder 6573* (DAO). Head of Katmai River, Katmai National Monument, *Cahalane 518* (US). Ca. 40 mi. east of Cape Lisburne, 4 mi. inland along Pitmegea River, *Cantlon & Gillis 57–2453* (MSC). Okpilak River, 69°23′N., 144°04′W., *Cantlon & Gillis 57–2287* (MSC, US). Glacier Bay, *Cooper 222* (US). Columbia Bay, Prince William Sound, *Cooper 315* (F, MIN). Port Vita, Raspberry Island, Kodiak group, *Eyerdam 5137* (CAS, DAO, MIN). Sable Pass, Mt. McKinley National Park, *Frohne 54–256* (DS). Tangle Lakes area, east of Landmark Gap, Alaska Range, *Gjaerevoil 1324* (CAN). Mead River village, Northern Coastal Plain, *Hultén s.n.*, 5–8 August 1960 (US). Dexter Creek, Nome, Seward Peninsula, *Porsild & Porsild 1340* (CAN). Pastolik, Norton Sound, *Porsild & Porsild 985* (GH). Unalaklet, Norton Sound, *Porsild & Porsild 1148* (CAN). Point Hope, *Scamman 6390* (GH). Columbia Glacier, Heather Island, 60°N., 147°W., *Viereck & Viereck 2312* (COLO). Naivak, 7 mi. southwest of Point Barrow, *Wiggins 12604* (DS, GH, UC, US, WTU). Point Barrow, *Wiggins 12946* (DS, GH, UC, WTU). Cape Thompson, 68°05′N, 165°40′W., *Wood & Wood 511* (CAN). ALEUTIAN ISLANDS: Amchitka Island, *Erdman 578* (COLO). Amlia Island, *Eyerdam 1244* (CAS, DS, GH). Nunivak Island, *Haley s.n.*, 1 July 1927 (CAS). Attu Island, *Hardy 385* (GH, MIN, WTU). Umnak Island, Nikolski, *Hultén 7041* (CAS). Unalaska, *Hultén 6708b* (US). Adak Island, *Jordal 2621-A* (MICH, US). Atka Island, *Oliver & Oliver 55* (MICH, US). BERING SEA: Pribilof Islands, St. George Island, *Johnston s.n.*, 5 May 1920 (CAS). Pribilof Islands, St. Paul Island, *Macoun s.n.*, 28 July 1891 (GH, MO, NY, US). St. Lawrence Island, Gambell, *Anderson 5185* (CAN).

Despite the widely used name *Sagina intermedia* Fenzl, *S. nivalis* (Lindbl.) Fries is adopted as the correct name for the taxon. No type material of either name appears to exist. However, Lindblom's description in 1838 and the even more detailed description by Fries in 1842, given when he elevated the taxon to specific rank, clearly refers to the same taxon published as *S. intermedia* by Fenzl in 1842.

Sagina nivalis, which is otherwise an Arctic species, occurs as a disjunct population in Alberta. Plants on Mt. Edith Cavell, Jasper National Park, representing morphologically good *S. nivalis* (confirmed by chromosome count of $2n = 88$ by J. K. Morton) occur mixed with *S. saginoides.* Specimens appearing intermediate between the two taxa are present here and occur occasionally elsewhere in Jasper and Banff National Parks.

There are several specimens from alpine habitats in Colorado, Utah and Wyoming which are suggestive of *Sagina nivalis.* Although these 5-merous specimens are densely caespitose and the sepal margins are distinctly purple, they belong to *S. saginoides.* However, a few 4- and 5-merous specimens from Colorado do appear to be truly intermediate between the two taxa. J. K. Morton (personal communication, 1976) has obtained an intermediate chromosome count of $2n$ = c. 64 for one such specimen (*S. saginoides,* $2n = 22$; *S. nivalis,* $2n = 88$). I have seen no specimens from Colorado which are clearly *S. nivalis.*

6. **Sagina caespitosa** (J. Vahl) Lange in Rink, Grønl. Geogra. Stat. Beskr. **2**(6): 133. 1857.

Arenaria caespitosa J. Vahl, Icon. Fl. Danica **18:** 4. 1840. *Sagina nivalis* var. *caespitosa* (J. Vahl) Boivin, Nat. Can. **93:** 583–646. 1966. *Spergella caespitosa* (J. Vahl) Löve & Löve, Bot. Notiser **128:** 508. 1975. TYPE: Groenlandica. (Lectotype, C!)

Perennial. Caespitose, forming small mats or cushions. Basal rosette of leaves lacking; secondary rosettes usually present, leaves linear to linear-subulate. Flowering stems numerous, ascending to radiating, frequently purple tinged. Cauline leaves subulate, becoming shorter toward apex, midvein frequently conspicuous; connate leaf bases forming shallow scarious cup, often purplish. Pedicels long, filiform, glandular pubescent, rarely glabrous (in North American plants). Flowers 5-merous or 5- and 4-merous. Sepals 2.0–2.5 mm long, broadly ovate to lanceolate, obtuse to somewhat

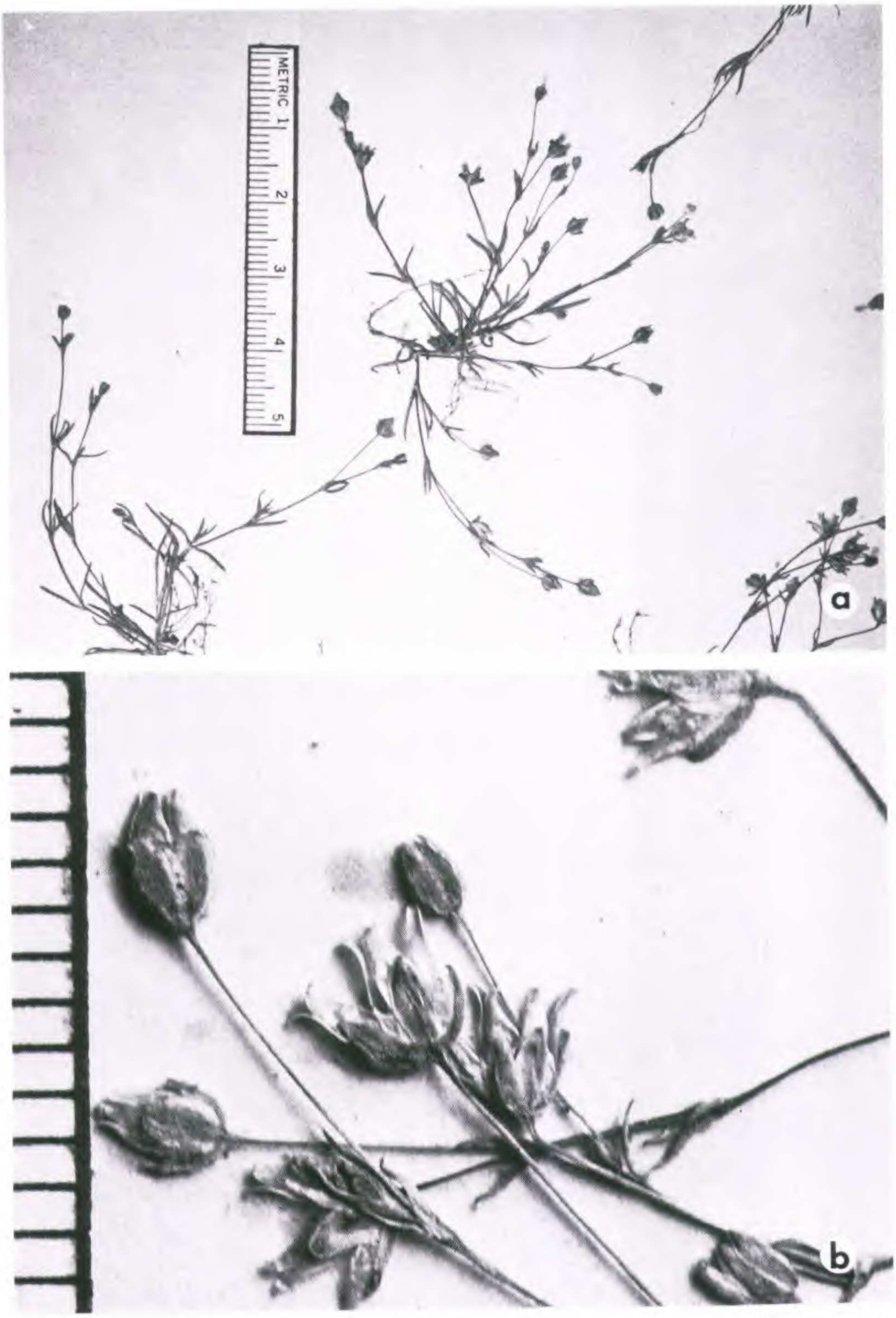

Figure 20. *Sagina decumbens* ssp. *occidentalis*. a. habit; b. close-up. Both Santa Cruz Is., California (*Howell 6356*, CAS).

acute, hyaline margins usually purple tinged, at least at the tip. Calyx base glandular pubescent or glabrous. Petals 2.5–3.0 mm long, exceeding, seldom equaling, sepals. Stamens 10 or 8, filaments 1.5–2.0 mm long, anthers 0.25–0.3 mm long. Capsules 5- or 4-valved, 3.0–3.5 mm long, dehiscing to base. Capsule valves thick. Sepals remaining appressed following capsule dehiscence. Seeds brown, obliquely triangular, with dorsal groove, distinctly notched at hilum, lateral surfaces frequently with elongate ridges, dorsal surface appearing smooth to pebbled, 0.5 mm long. Chromosome number: $2n = 88$, 100 (higher than). Figure 16.

ECOLOGY AND DISTRIBUTION: In wet sands and gravels of shorelines and stream margins, wet mossy places, and dry rocky barrens and gravelly hillocks. Northeast Arctic, south to northern Manitoba, James Bay and northern Labrador. Amphi-Atlantic. Flowering July and August. Figure 17.

REPRESENTATIVE SPECIMENS: **Canada.** LABRADOR: Cape Mugford Peninsula, Kaumajet Mts., 57°50′N., 62°50′W., *Abbe 269* (GH). East Bay, Ikordlearsuk, Torngate region, 59°57′N., 64°24′W., *Abbe & Odell 270* (GH). MANITOBA: Baralzon Lake, 60°00′N., 98°10′W., *Scoggan & Baldwin 8206* (CAN, MIN). NORTHWEST TERRITORIES: District of Franklin, Inugsuin Fiord, Baffin Island, ca. 70°N., 68°30′W., *Hainault 3836* (CAN). Beekman Peninsula, southeast Baffin Island, ca. 63°20′N., 64°50′W., *McLaren 142* (CAN). Pangnirtung, Baffin Island, *Polunin 1568* (WIS). Point Brewster, Frobisher Bay, Baffin Island, *Potter 8237* (GH). Resolution Island, Frobisher Bay, Baffin Island, *Potter 8238* (GH). Tolnes Road, Baffin Island, 66°27′N., *Seidenfaden 1281* (NY). Isortoq Fiord, Baffin Island, ca. 70°N., 77°W., *Webber 407* (CAN). District of Keewatin, Cape Jones, *Baldwin, Hustich, Kucyniak & Tuomikoski 681a* (CAN). Kaminak Lake, 62°N., 95°W., *Güssow 114a* (DAO). Port Burwell, Hudson Strait, 60°22′N., 64°50′W., *Malte s.n.*, 25–28 July 1928 (CAN, GH). Baker Lake, north shore, 64°30′N., 97°W., *Porsild 6094* (CAN). Kazan River, 62°30′–63°N., 97°–98°30′W., *Porsild 5798* (CAN). QUEBEC: Fort Chimo area, 58°07′N., 68°23′W., *Calder 2662* (DAO). Fort George, James Bay, 53°53′N., *Dutilly & Ernest 12500* (GH). Korok River, east side of Ungava Bay, 42 mi. inland from Korok Bay, 58°35′N., 64°15′–66°W., *Rousseau 1111* (DAO).

This species can be typified by Vahl's specimen in the type collection at Copenhagen (C) in the folder marked "Flora danica, TAB 2289" and labelled "Spergula sp. n., Groenlandia". I have chosen this specimen which is similar, though not identical, to the illustration accompanying the original description to serve as the lectotype. Vahl regarded the plant as having close affinities with *Spergula* (*Sagina*) *saginoides* and thus labelled his specimens *Spergula,* but at the time of publication he used the combination *Arenaria caespitosa* rather than placing his taxon in *Spergula.*

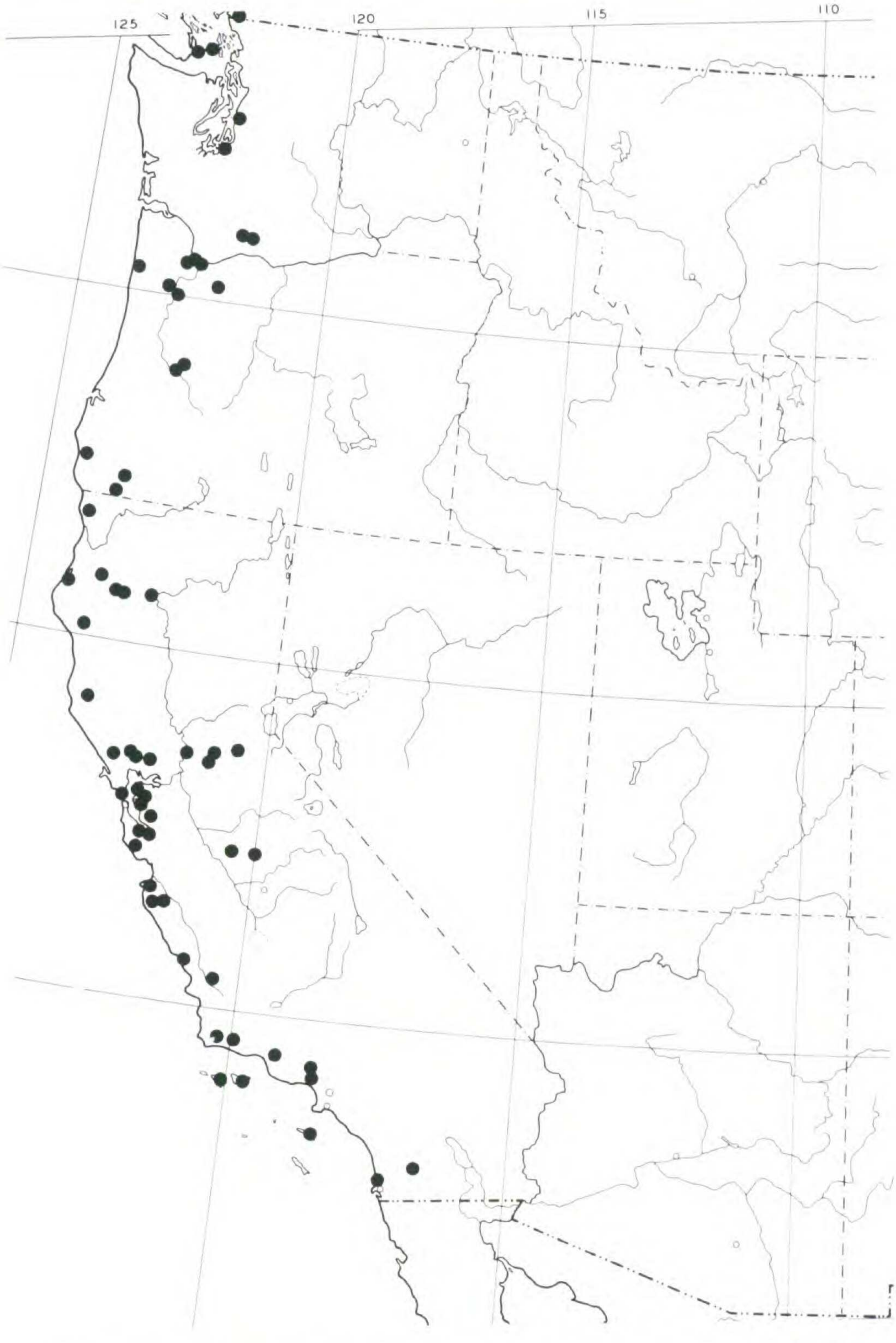

Figure 21. Geographical distribution of *Sagina decumbens* ssp. *occidentalis*.

The material from North America and western Greenland differs from European plants of this taxon in having glandular trichomes on the upper portion of the pedicels and on the calyx bases. While European plants are totally glabrous, the amount of glandular pubescence in the North American material is variable. Weakly glandular plants are frequent and occasionally glabrous specimens are encountered. Among glandular pubescent plants examined, an average of 70% of the flowers exhibited glandular pubescence while 30% of the flowers of these same plants were glabrous. Separate nomenclatural recognition of European and North American material seems unnecessary.

7a. **Sagina decumbens** (Ell.) T. & G., Fl. N. Am. **1:** 77. 1838. ssp. **decumbens**

Spergula decumbens Ell., Sketch **1:** 523. 1821. TYPE: unknown.
Sagina subulata var. *Smithii* Gray, Manual 5 ed. p. 95. 1867. *Sagina decumbens* var. *Smithii* (Gray) Watson, Manual 6 ed. p. 89. 1889. TYPE: *C. E. Smith s.n.*, June 1865, sandy road in the pine woods, at the mouth of Great Harbor, New Jersey (Lectotype, GH!).

Annual with slender taproot. Branches slender, ascending or decumbent. Basal rosette of leaves lacking or early deciduous. Lower cauline leaves linear, 4–22 mm long, leaf bases connate, typically with conspicuous hyaline margins, connate portion not generally appearing inflated, apices apiculate. Stems and connate leaf bases frequently purple tinged. Upper cauline leaves becoming subulate toward apex, 1.5–5 mm long at tip, apiculate. Pedicels filiform, glabrous or glandular pubescent. Flowers 5-merous, rarely 4-merous. Calyx base glabrous or glandular pubescent, often sparsely so. Sepals ovate, hyaline margin conspicuous, margins or apex frequently purple. Sepals (1.0–) 1.5–2.0 (–3.0) mm long. Petals elliptical, slightly exceeding sepals at anthesis, equal or shorter than sepals during capsule development, (0.75–) 1.0–2.0 (–2.25) mm long. Stamens 10 or fewer, filaments (1.0–) 1.5 mm long, anthers 0.25 mm long. Capsule valves thin, 2.0–3.0 (–3.5) mm long, dehiscing less than half the length of the capsule. Sepals remaining appressed after capsule dehiscence. Seeds light tan, obliquely triangular, with dorsal groove, surface smooth or tuberculate, with delicate reticulate ridge pattern (sometimes obscure), (0.25–) 0.3–1.4 mm long. Chromosome number $2n = 36$. Figure 18.

ECOLOGY AND DISTRIBUTION: In moist or dryish sandy places, frequently at field margins, open pine woods, paths, roadsides, sidewalk cracks and lawns. Southeastern half of the United States, from Massachusetts, Connecticut, and southern New Jersey, southern Ohio, southern Indiana, Illinois, Missouri and southeastern Kansas, south to northern Florida and eastern Texas. Disjunct populations in Arizona, Alberta, New Brunswick and Vermont. Only those in Arizona are verified by specimens collected this century. *Sagina decumbens* ssp. *decumbens* is chiefly a Coastal Plain and Piedmont taxon. It appears to have extended its range westward with civilization, particularly into Kansas, Oklahoma, northeast Texas, Arizona, Alberta and Saskatchewan. Flowering April to June. Figure 19.

REPRESENTATIVE SPECIMENS: **Canada.** ALBERTA: east of Hand Hills, *Macoun s.n.*, 8 August 1879 (CAN, DAO). Buffalo Plains, *Macoun s.n.*, 10 August 1879 (US). NEW BRUNSWICK: St. John, *Fowler s.n.*, 30 June 1877 (DAO). SASKATCHEWAN: Hillsides, Farewell Creek, Cypress Hills, *Macoun s.n.*, 27 June 1895 (CAN).

United States. ALABAMA: Cullman Co., Cullman, *Mohr s.n.*, 1 April 1884 (US). Escambia Co., Atmore, *Blanton 201* (DAO, F, GH, MICH). Lee Co., Auburn, *Earle & Baker s.n.*, 18 April 1898 (F, NY, RM, US). Mobile Co., Mobile, *Mohr s.n.*, 24 March 1861 (US). ARIZONA: mountains between Miami and Superior (border of Pinal and Gila Counties), *Nelson & Nelson 1907* (CAS, GH, MO, NY, RM, UC, US). Pima Co., Rincon Range Station, *Darrow s.n.*, 11 April 1937 (CAS). ARKANSAS: Brenton Co., Decatur, *Plank s.n.*, April 1899 (NY). Bradley Co., Warren, *Demaree 21484* (GH). Clay Co., Corning, *Letterman s.n.*, May 1884 (MO). Franklin Co., Mulberry River, Cass, *Fassett 17439* (WIS). Greene Co., specific locality unknown, *Eggert s.n.*, 29 April 1893 (MO). Hempstead Co., Fulton, *Bush 2434* (MO). Independence Co., Newark, *Eggert s.n.*, 23 April 1896 (MO). Nevada Co., Prescott, *Bush 533* (MO). Pulaski Co., Little Rock, *Demaree 22725* (MO). Washington Co., Savoy, *Fassett 17440* (WIS). CONNECTICUT: Fairfield Co., Fairfield, *Eames s.n.*, 19 June 1898 (GH, NEBC). New Haven Co., Milford, *Eames s.n.*., 7 June 1898 (GH). Middlesex Co., Gildersleve, *Blewitt 644* (NEBC). DELAWARE: Kent Co., Choptank Mills, *Tatnall 2130* (GH). Sussex Co., Bethany Beach, *Tatnall 3321* (GH). DISTRICT OF COLUMBIA: Washington, *Morong s.n.*, 22 May 1877 (NY). FLORIDA: Alachua Co., Gainsville, *Wiggins 19394* (NY). Bay Co., Lynn Haven, *Banker 3671* (NY). Duval Co., near Jacksonville, *Curtiss 6353* (DS, GH, MIN, MO, NY, UC, US). Gilchrist Co., 9 mi. south of Bell, *Wiggins 19493* (DS). Hillsborough Co., no specific locality, *Fredholm 6314* (GH, MIN). Jackson Co., Marianna Caverns State Park, *Godfrey 55331* (GH, NY). Leon Co., near Tallahassee, *Rugel s.n.*, April 1843 (MO). Liberty Co., Apalachicola River swamp south of Bristol, *Small, DeWinkeler & Mosier 11263* (NY). St. Johns Co., St. Augustine, *Leeds s.n.*, 4 March 1893 (F). GEORGIA:

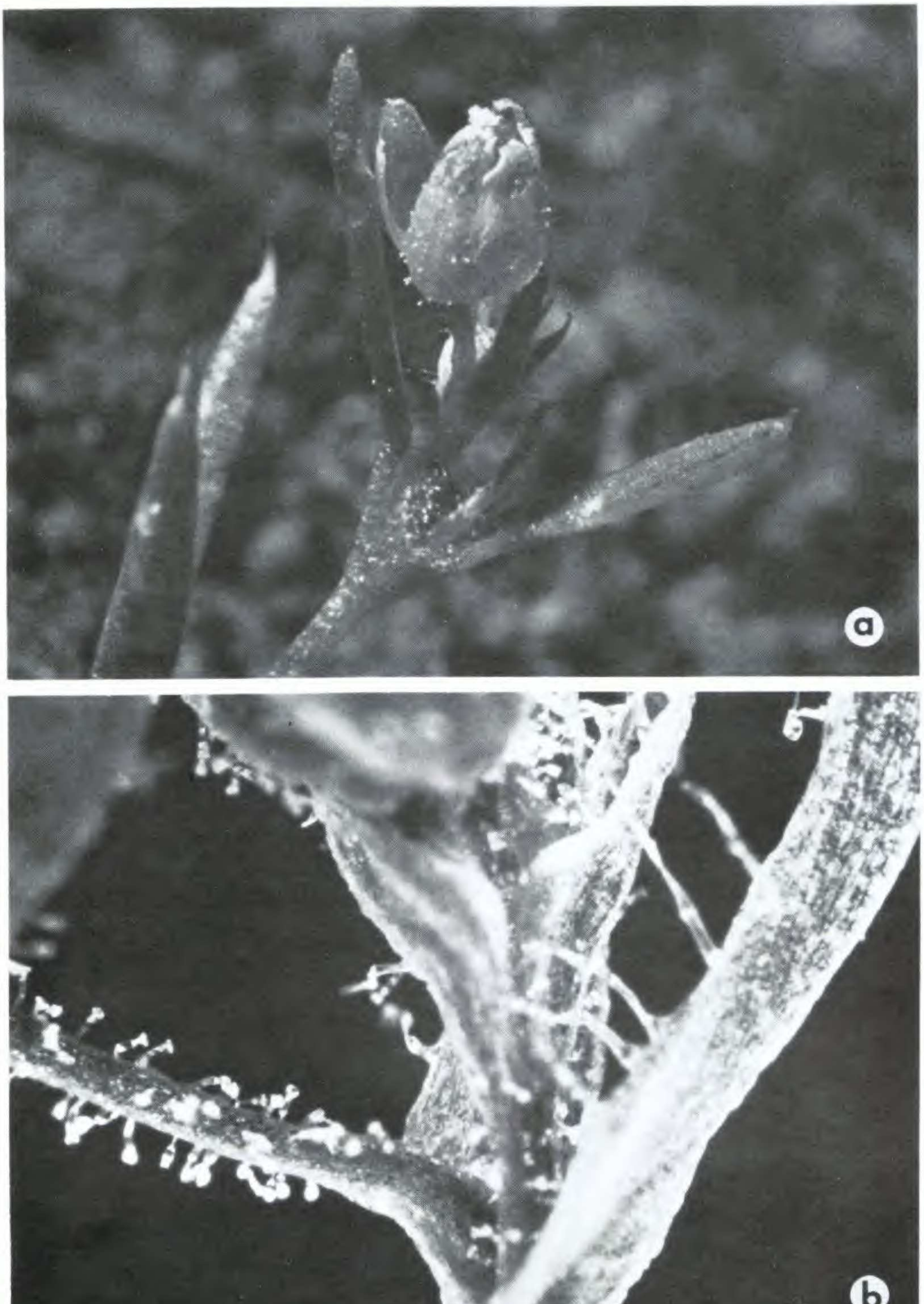

Figure 22. *Sagina apetala*. a. living specimen; b. close-up showing glandular trichomes on pedicel and cilia of leaf base (photographed under epi-illumination). Both California (*Crow 1176*, MSC).

Bartow Co., 2¼ mi. northwest of Acworth, 7½ mi. southeast of Centerville, *Duncan 8041* (MO). Calhoun Co., Edison, *Collom s.n.*, 18 April 1953 (MO). Chatham Co., Tybee Island, *Harper 2175* (GH, MO, US). Clarke Co., 3 mi. west of Winterville, *Cronquist 4237* (GH, NY, US). Dekalb Co., Stone Mountain State Park, *Crow 1919* (MSC). Glynn Co., 5 mi. west of Brunswick, *Cronquist 4913* (US). Gwinnett Co., Yellow River near McGuire's Mill, *Small s.n.*, 7 May 1895 (F, NY). Macon Co., near Macon, *Mohr s.n.*, April 1915 (US). Rabun Co., canyon at Tallulah Falls, *Small s.n.*, 20 April 1893 (F). Richmond Co., Augusta, *Crow 1926* (MSC, NHA). Wilkes Co., just east of Dry Fork of Long Creek, between Washington and Lexington, *Cronquist 4229* (GH, MICH, MO, NY, UC, US). ILLINOIS: Champaign Co., Urbana, *Jones 19605* (DAO). Jackson Co., Giant City State Park, *Fassett 21467* (WIS). Johnson Co., Vienna, *Winterringer 6281* (F). Peoria Co., Peoria, *Chase 10374* (F). Pulaski Co., Wetang, *Vasey s.n.*, no date (F, NY). Union Co., Cobden, *Earle 693* (NY). INDIANA: Brown Co., Nashville, *Lyon s.n.*, 22 May 1930 (MICH). Clark Co., Charlestown, *Baird s.n.*, 2 June 1877 (MICH). Jefferson Co., Hanover, *Barnes 17* (WIS). Posey Co., Mt. Vernon, *Deam 56156* (GH). Spencer Co., Rockport, collector and date unknown (GH). KANSAS: Cherokee Co., 2 mi. northwest of Baster Springs, *McGregor 15337* (US). KENTUCKY: Lyon Co., Kuttawa, *Eggleston 4641* (MIN, NY). LOUISIANA: East Baton Rouge Parish: Baton Rouge, *Brown 860* (NY). Iberia Parish: Weeks Island, *Thieret 16999* (US). Iberville Parish: Plaquemine, *Barnhart 2822* (NY). Lafayette Parish: Lafayette, *Thieret 10333* (DAO). La Salle Parish: Catahoula Lake, 3 mi. southeast of Nebo, *Ewan 19066* (GH). Plaquemines Parish: Point la Hache, *Langlois s.n.*, April 1883 (NY, UC). Rapides Parish: Bluffs of Red River, vicinity of Alexandria, *Ball 411* (MO, NY, US). St. Martin Parish: St. Martinville, *Langlois s.n.*, 15 March 1892 (MICH, MIN). St. Tammany Parish: vicinity of Covington, *Arsène 11978* (US). MARYLAND: Talbot Co., 2¼ mi. southwest of Longwoods, *Earle 4062* (GH). Worcester Co., 10 mi. southeast of Salisbury, *Tatnall 1773* (WS). MASSACHUSETTS: Hampden Co., West Springfield, *Owen s.n.*, June 1884 (NEBC). Hampshire Co., Hadley, no collector, July 1875 (NEBC). Norfolk Co., Braintree, Cranberry Pond, *Kidder s.n.*, 12 June 1886 (NEBC). MISSISSIPPI: Carroll Co., North Carrollton, *Clute 35* (F, NY). Forrest Co., southeast of Hattiesburg, *Cooley, Pease & Ray 3243* (GH). Jackson Co., Biloxi, *Tracy 5040* (F, MICH, MO, MSC, NY). Lee Co., Natchez Trace Parkway, *McDougall 1804* (US). Pearl River Co., 3 mi. north of Picayune, *Rose 8046* (CAS). Warren Co., Snyder's Bluff, *Cooley 3336* (GH). MISSOURI: Barry Co., Eagle Rock, *Bush 507* (MO). Bollinger Co., 5 mi. west of Grassy, *Steyermark 18982* (MO). Boone Co., 4 mi. southeast of Ashland, *Drones 1910* (CAS, GH). Butler Co., Neelyville, *Bush 36* (MIN); 5 mi. southwest of Qulin, *Steyermark 26655* (F). Carter Co., Grandin, *Bush 340* (MO). Cedar Co., 3 mi. north of Stockton, *Steyermark 18655* (MO). Christian Co., Chadwick, *Bush 4441A* (MO). Dallas Co., between Plad and Buffalo, *Steyermark 18691* (MO). Douglas Co., along north fork of White River between Roosevelt and Richville, *Steyermark 19156* (MO). Dunkin Co., about 5 mi. northwest of Campbell, *Steyermark 398* (MO). Franklin Co., Pacific, *Eggert s.n.*, 23 May 1882 (MO, NY, US). Greene Co., specific locality unknown, *Blankinship s.n.*, 23 April 1888 (MO). Henry Co., 3 mi. northeast of Finey, *Steyermark 18774* (MO). Jefferson Co., *Hasse s.n.*, 24 May 1887 (MO). Laclede Co., north of Hazel Green, *Steyermark 8075* (MIN). Lawrence Co., east of Chesapeak, *Steyermark 4519* (MO). MacDonald Co., specific locality unknown, *Bush s.n.*, 24 April 1891 (MO). Miller Co., 4 mi. south of Bogville Dam, *Steyermark*

18798 (MO). Oregon Co., 4 mi. south of Koshkonong, *Steyermark 18970* (MO). Osage Co., east of Linn, *Steyermark 18709* (MO). Phelps Co., 4 mi. southeast of St. James, *Steyermark 22188* (F). Polk Co., north of Burns, *Steyermark 18655* (MO). Pulaski Co., 1 mi. west of Jerome, *Steyermark 4600* (MO). Reynolds Co., south of Ellington, *Steyermark 7944* (MO). St. Francois Co., Bismark, *Russell s.n.*, 15 April 1898 (MO). St. Louis Co., Forest Park (in St. Louis), *Steyermark 1728* (F). Scott Co., 2 mi. south of Benton, *Steyermark 10256* (MO). Shannon Co., Montier, *Bush 54* (MO). Texas Co., along Jack's Fork of Current River, 3 mi. south of Arroll, *Steyermark 18588* (MO). Wayne Co., south of Greenville, *Anderson s.n.*, 31 May 1939 (MO). NEW JERSEY: Atlantic Co., Somer's Pt., *Smith s.n.*, June 1865 (MO, NY). Bergen Co., near Hewitts, *Britton s.n.*, 29 June 1886 (NY). Burlington Co., Atsion, *Canby s.n.*, August 1863 (NY). Camden Co., Camden, *Parker s.n.*, 4 July 1866 (MO). Cape May Co., Cold Springs, *Brown 5236* (GH). Ocean Co., Forked River, *Churchill s.n.*, 27 May 1891 (GH); Surf City, *Long 3821* (GH). NEW YORK: Nassau Co., Rockaway, *Schrenk s.n.*, 30 May 1879 (MICH). Suffolk Co., Wading River, *Miller s.n.*, 22 May 1874 (F). NORTH CAROLINA: Buncombe Co., Asheville, *Hayne 2766* (F). Carteret Co., Beaufort, *Morton 2198* (US). Brunswick Co., Smith Island, *Morton 2118* (US). New Hanover Co., near Wilmington, *Canby s.n.*, May 1867 (MICH, NY). Northampton Co., Garysburg, *Ahles 38345* (DAO). Orange Co., Chapel Hill, *Carlton 38* (MIN). Pitt Co., Gardnerville, *Radford 32534* (NY). Robeson Co., Lumberton, *Knowlton s.n.*, 9 April 1924 (GH). Rowan Co., vicinity of Heilio's Mill, *Small & Heller s.n.*, 4–9 June 1891 (WTU). Wake Co., Raleigh, *Godfrey s.n.*, 8 April 1937 (GH). OHIO: Lawrence Co., Ironton, *Werner s.n.*, 27 May 1892. OKLAHOMA: Carter Co., 6 mi. northwest of Ardmore, *Nelson, Nelson, Goodman & Waterfall 5696* (RM). Comanche Co., vicinity of Fort Sill, *Clemens 11576* (MO). Craig Co., Vinita, Indian Territory, *Carleton 12* (NY, US). Cleveland Co., 2 mi. east of Norman, *Bruner s.n.*, 15 April 1924 (MO, RM). Marshall Co., near Lake Texoma, *Goodman 5806* (GH, US). Murray Co., Crusher Spur, *Stevens 52* (DS, MIN, MO, NY, US). Pontotoc Co., 4–5 mi. east of Ada, *Robbins 2339* (UC). PENNSYLVANIA: Bucks Co., Doylestown, *Pond s.n.*, 27 May 1885 (US). Lancaster Co., Safe Harbor, *Porter s.n.*, 15 May 1861 (NY). Philadelphia Co., ballast ground, Philadelphia, *Parker s.n.*, 30 May 1865 (NY). SOUTH CAROLINA: Allendale Co., Fairfax, *Ahles 10616* (COLO). Beaufort Co., Beaufort, *Churchill 379* (MO). Charleston Co., Charleston, *Smith s.n.*, April 1865 (GH). Dorchester Co., Summerville, *Hunnewell 8139* (MIN). Edgefield Co., north of Edgefield, *Steyermark 63373* (F). Horry Co., Longwood Landing, *Weatherby & Griscom 16524* (NY, US). Kershaw Co., Lynches River, 7 mi. south of Jefferson, *Redford 9068* (WTU). TENNESSEE: Decatur Co., specific locality unknown, *Ames s.n.*, July 1865 (MICH). Franklin Co., north of Estill Springs, *Svenson 9993* (GH). Grundy Co., Goose Pond, near Pelham, *Svenson 7618* (GH). Knox Co., Knoxville, *Ruth 4310* (MO). Obion Co., near Samburg, *Eyles 7801* (GH). Roan Co., Harriman, *McMorine s.n.*, 22 April 1893 (DAO). Shelby Co., near Memphis, *Palmer 17447* (MO). TEXAS: Bastrop Co., Alum Creek, south of Bastrop State Pines Park, *Tharp, Warnock & Barkley 16T011* (F, UC). Bell Co., near Belton, *Wolff 374* (US). Burnet Co., 3 mi. south of Bertram, *Johnson 6158* (DS). Colorado Co., Columbia, *Bush 96* (MIN). Dallas Co., Dallas, *Reverchon s.n.*, April 1876 (MO, NY). Denton Co., 4½ mi. north of Grapevine, *Whitehouse 17970* (MICH). Fayette Co., specific locality unknown, *Wurzlow s.n.*, in 1891 (F). Fannin Co., Bonham, *Milligan s.n.*, April 1892 (US). Galveston Co., Galveston, *Lindheimer s.n.*, April 1863 (MO). Gon-

zales Co., Ottine Swamp, *Cory 18133* (GH). Harris Co., Houston, *Bush 27* (MO). Kleberg Co., Kingsville, *Rees 37* (NY). Liberty Co., Liberty, *Palmer 7733* (MIN). Matagorda Co., Matagorda, *Palmer 4253* (MO). Montgomery Co., near Conroe, *Palmer 33339* (GH). Tarrant Co., near Handley, *Ruth 452* (F, NY, US, WIS). Travis Co., Austin, *Tharp s.n.*, 19 March 1932 (CAS, GH, MICH, NY, UC, WTU). Van Zandt Co., west of Canton, *Correll & Correll 35679* (UC). Walker Co., specific locality unknown, *Warner 64* (GH, US). Woods Co., Mineola, *Reverchon s.n.*, 22 April, no year (MO). VERMONT: Windham Co., Brattleboro, *Grout s.n.*, 25 July 1895 (GH, NEBC). VIRGINIA: Bedford Co., specific locality unknown, *Curtiss s.n.*, 20 May 1872 (F, MO). Dinwidde Co., near Burgess Station, *Fernald & Long 9917* (GH). Greensville Co., 1 mi. south of Emporia, *Fernald & Long 7016* (NY, US). Hampton Co., Hampton, *Chickering s.n.*, 15 May 1877 (NY). Nansemond Co., Norfolk, *Earll s.n.*, 14 May 1880 (US). Princess Anne Co., False Cape, *Fernald, Griscom & Long 4636* (NY). Pittsylvania Co., Danville, *Small & Heller 230* (DAO, F, GH, MIN, MO, US). Henrico Co., Richmond, *Churchill s.n.*, 11 May 1894 (GH). Smyth Co., south fork of Holston River near Add Wolf, *Small s.n.*, 15 June 1902 (F). York Co., Yorktown, *Thomas 2694* (DS). Southampton Co., Franklin, collector unknown, May 1867 (GH).

There is considerable pubescence variation in this taxon. Pubescent forms predominate three to one over glabrous forms with no geographical segregation of the character. Within the pubescent forms there is a complete range from just a few flowers with glandular hairs to all flowers on a single plant bearing glandular trichomes.

Presence of the tuberculate seed character is likewise variable and without geographical segregation. While only smooth seeds or tuberculate seeds may be present in a single population, frequent occurrences of mixtures of the two seed types are encountered. The frequency of the tuberculate seed type is about 60 percent.

The nomenclature has been somewhat confusing in *Sagina decumbens* ssp. *decumbens*. In *A Flora of North America* Torrey and Gray (1838) correctly transferred *Spergula decumbens* Ell. to *Sagina*. In the same work they included *Sagina subulata*, based on a collection cited as "Rocky Mountains, Drummond" (p. 178), and simultaneously made the transfer of *Spergula subulata* Swartz to *Sagina*. The description provided for this taxon more nearly applies to *Sagina decumbens* ssp. *decumbens* and is not descriptive of any of the Saginas native to the Rocky Mountains.

In Gray's *Manual of the Botany of the Northeastern United States* ed. 2 (1856) the name *Sagina decumbens* is replaced by the name *Sagina Elliottii* Fenzl with *Spergula decumbens* Ell. indicated as the synonym. The binomial *Sagina Elliottii* was never

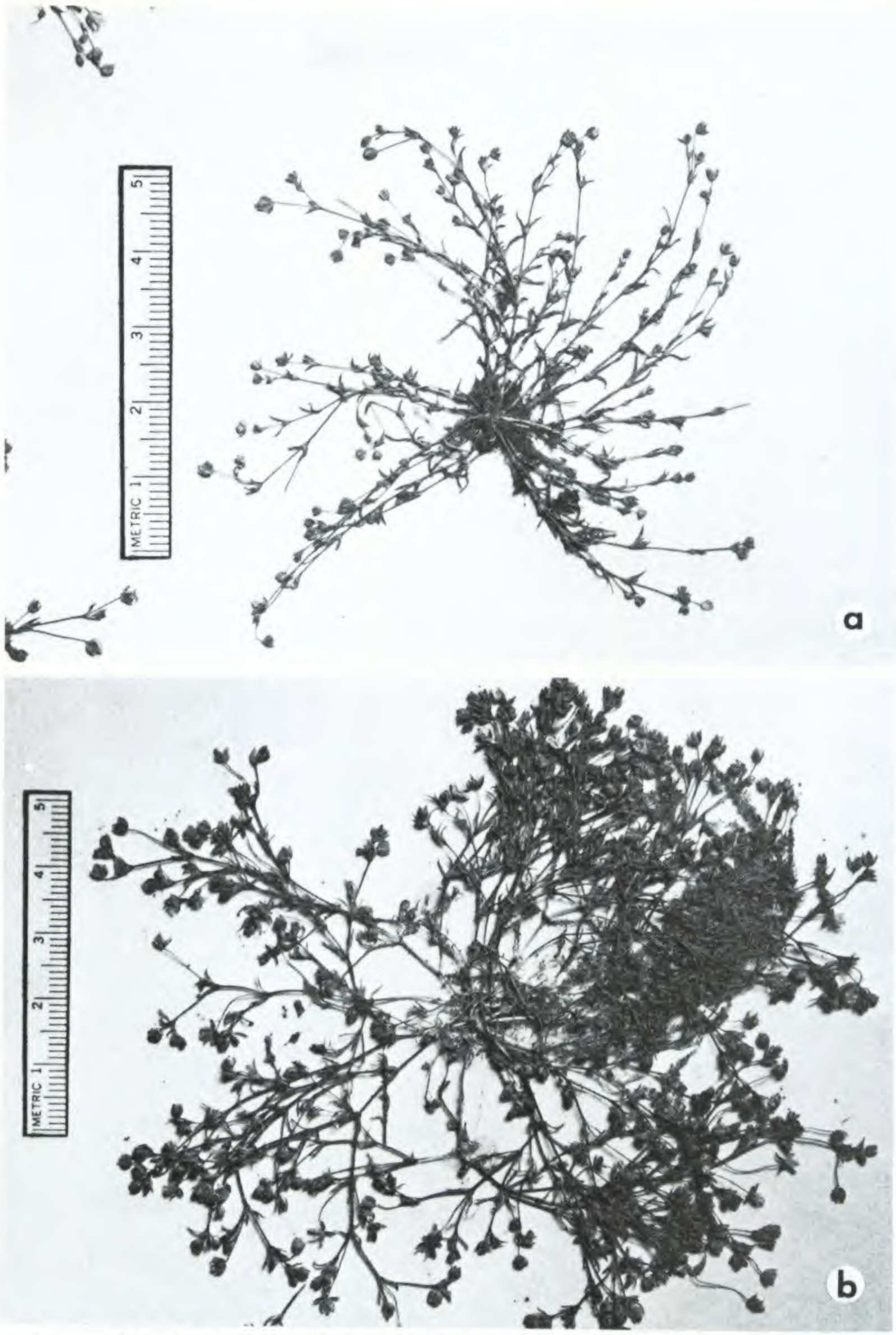

Figure 23. *Sagina apetala*. a. habit, California (*Howell 24202*, CAS); b. habit, California (*Raven & Johnson 21233*, DS).

validly published by Fenzl or Gray.

In the fifth edition of Gray's *Manual* (1867) *Sagina decumbens* is treated as *S. subulata,* Wimmer being recognized as the author of the transfer, and *Sagina Elliottii* is cited in synonymy. Gray also described a new variety of the taxon, *Sagina subulata* var. *Smithii* in that edition.

In Gray's *Manual* ed. 6 (1889, revised by Watson & Coulter), the binomial *Sagina decumbens* is correctly used for the taxon, and a nomenclatural transfer of var. *Smithii* to *Sagina decumbens* was made by Watson.

This slender, nearly apetalous variety described by Gray does not warrant recognition as a distinct taxon. Gray's variety represents an extreme in the range of variability of *Sagina decumbens* ssp. *decumbens* exhibiting a tendency toward a habit which is more slender, with much branched filiform stems and a greater frequency of 4-merous flowers which produce fewer-seeded capsules. The range of variability is continuous and it seems best to consider the material a single taxon.

No single specimen was cited with the original description to typify *Sagina subulata* var. *Smithii.* Of the four collections studied by Gray, all glued to a single sheet, only one specimen bears the notation "no petals" in Gray's handwriting. I therefore designate this specimen, *C. E. Smith s.n.,* June 1865, sandy road in the pine woods, at the mouth of Great Egg Harbor, New Jersey (GH), as the lectotype of *Sagina subulata* var. *Smithii.*

7b. **Sagina decumbens** ssp. **occidentalis** (Wats.) Crow, comb. nov.
BASIONYM: *Sagina occidentalis* Wats., Proc. Am. Acad. **10:** 344. 1875.

Alsinella occidentalis (Wats.) Greene, Fl. Franc. p. 125. 1891. TYPE: *Bolander 3891,* in the streets of Ukiah, Mendocino Co., California, 1864 (Holotype, GH!; isotypes, UC! MO! K! US!).

Annual with slender taproot. Branches slender, ascending or sometimes decumbent. Basal rosette of leaves lacking. Lower cauline leaves linear, 5.0–23 mm long. Upper cauline leaves becoming subulate toward tip, 1.0–4.5 mm long at apex. Cauline leaves apiculate. Pedicels filiform, weakly glandular pubescent or glabrous. Sepals ovate to orbicular, tips frequently purple, occasionally the entire hyaline margin purple tinged. Sepals (1.5–) 1.75–2.0 (–2.5) mm long. Petals elliptical, nearly equaling the sepals, (1.25–) 1.5–

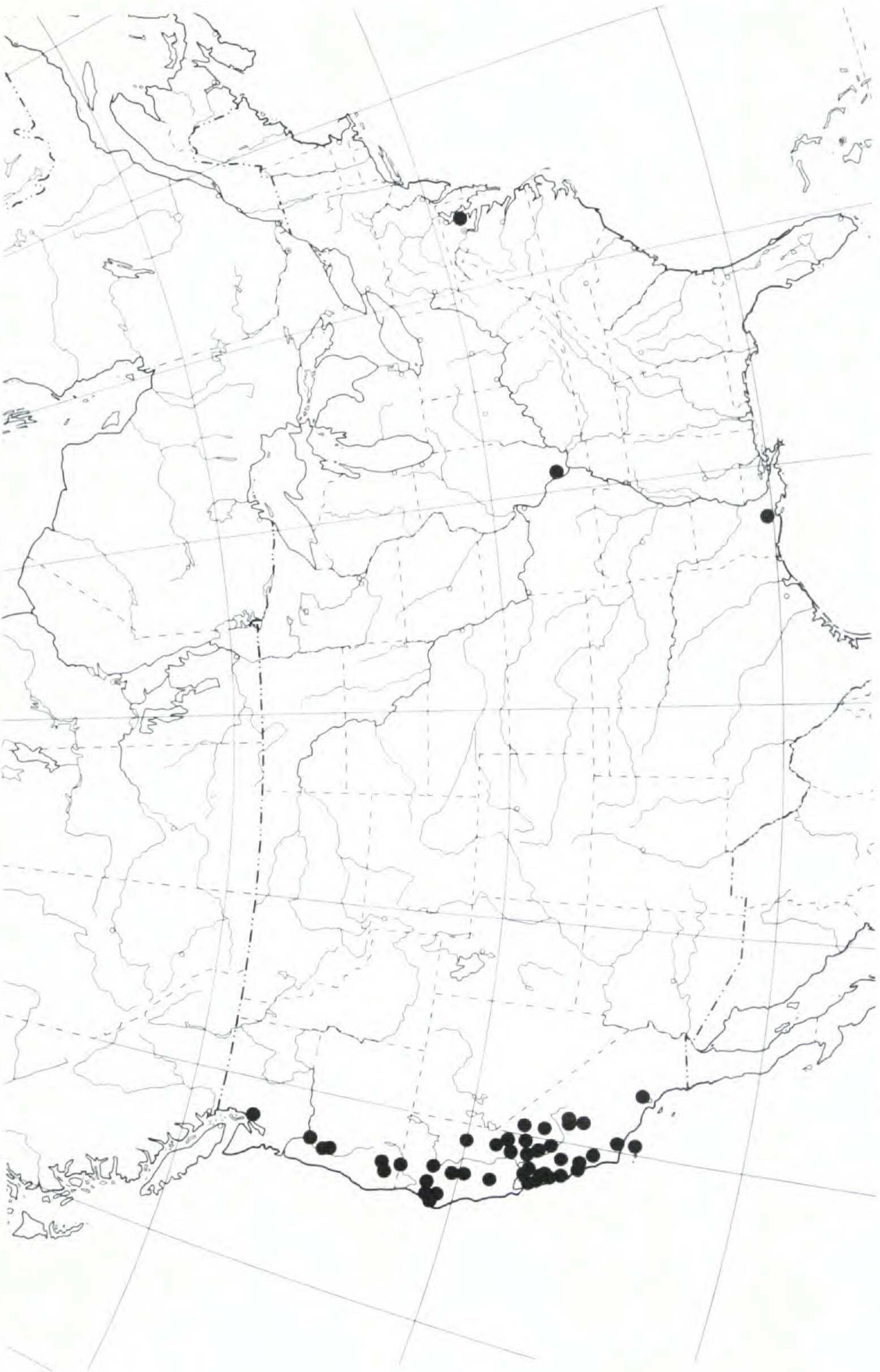

Figure 24. Geographical distribution of *Sagina apetala* in North America.

2.0 mm long. Stamens 5 or 10, filaments (1.0–) 1.5 mm long, anthers 0.25 mm long. Capsules globose prior to dehiscence. Valves thin, (2.0–) 2.5–3.0 (–3.5) mm long, dehiscing to ca. half the capsule length. Sepals remaining appressed following capsule dehiscence. Seeds light brown, obliquely triangular, with dorsal groove, surface smooth to slightly pebbled, rarely with elongate ridges on the lateral surfaces, 0.4 mm long. Figure 20.

ECOLOGY AND DISTRIBUTION: On dryish hillsides, margins of vernal pools, along streams, open spots in redwood and pine woods, along roadsides and around dwellings. Ranging northward from southern California along the Great Valley and Coastal Range to the southern border of British Columbia. Flowering April to June. Figure 21.

REPRESENTATIVE SPECIMENS: **Canada.** BRITISH COLUMBIA: Gordon Head, Vancouver Island, *Macoun s.n.*, 30 May 1887 (US). Vicinity of Victoria, Vancouver Island, *Macoun s.n.*, 23 May 1893 (F, MICH, MIN).

United States. CALIFORNIA: Alameda Co., vicinity of Oakland, *Holder 2522* (US). Amador Co., New York Falls, elev. 2000 ft., *Hansen 537* (DS, GH). Calaveras Co., Big Meadow, elev. 6600 ft., *Jepson 10084* (JEPS). Contra Costa Co., Rock City Camp, Mont Diablo, *Bowerman 2028* (UC). Del Norte Co., Gasquet to Patricks, *Bacigalupi 8542* (DS). Humboldt Co., Garberville, *Tracy 16212* (UC). Los Angeles Co., Pasadena, *Grant s.n.*, 28 March 1898 (DS); Avalon, Santa Catalina Island, *Trask s.n.*, February 1898 (US). Madera Co., along Fresno-Yosemite road (Calif. 41), 3 mi. north of crossing with Madera Lateral, elev. 750 ft., *Bacigalupi 4876A* (JEPS). Marin Co., McClure Beach, Pt. Reyes National Seashore, *Crow 1180a* (MSC). Mariposa Co., Mariposa, *Congdon s.n.*, 11 April 1897 (MIN). Mendocino Co., Ukiah, *Bolander 3891* (GH, MO, UC, US). Albion Ridge, *McMurphy 31* (DS). Merced Co., 5½ mi. southeast of Planada, north of LeGrand, elev. 245 ft., *Bacigalupi 7339* (JEPS, RM, WTU). Monterey Co., Pacific Grove, *Heller 8502* (DS, F, GH, MIN, MO, NY, WTU). Napa Co., Howell Mountain, 3–4 mi. east of Angwin's, *Tracy 1503* (UC). Riverside Co., Lake Suprise, San Jacinto Mts., *Reed 2442* (UC). Sacramento Co., Elk Grove, *Congdon s.n.*, 31 March 1894 (MIN). San Diego Co., Spencer Valley, near Julian, *Abrams 3797* (DS, NY). San Francisco Co., Point Richmond, *Hall 1663* (GH, MIN). San Luis Obispo Co., Price Canyon, *Hoover 6751* (CAS, UC). San Mateo Co., road from La Honda to Prescadero Creek, *Mason 3685* (UC). Santa Barbara Co., Mission la Purisima, *Jepson 11937* (JEPS); Lady's Cove, East Canyon, Santa Cruz Island, elev. 400 ft., *Wolf s.n.*, 27 March 1932 (DS). Santa Clara Co., Isabel Creek, east base of Mt. Hamilton, elev. 2100 ft., *Sharsmith & Sharsmith 1156* (UC). Santa Cruz Co., near Jamison Creek, *Hesse 2775* (DS). Shasta Co., Olinda, *Blankenship 5* (JEPS, WS). Solano Co., Violet Station, near Vacaville, *Jepson 1205a* (JEPS). Sonoma Co., Santa Rosa, *Eastwood 10329* (CAS). Trinity Co., Junction City, *Tracy 7530* (UC). Tuolumne Co., Mather, elev, 1400 m, *Clausen 1549* (DS). Ventura Co., Kennedy Canyon. Ventura River basin, *Pollard s.n.*, 5 May 1946 (CAS). OREGON: Clackamas Co., Oregon City, *Thompson 687*

(WTU). Clatsop Co., beach near Seaside, *Morrill 89* (WTU). Columbia Co., St. Helens, *Suksdorf s.n.*, 28 May 1895 (WS). Curry Co., Port Orford, *Peck 8454* (GH, MO, NY). Jackson Co., Wimir, *Hammond s.n.*, 21 May 1892 (MO). Josephine Co., Grants Pass, *Piper 5101* (WS). Lane Co., 4 mi. above Takilma on the East Fork of the Illinois River, *Henderson 5892* (CAS, DS, MO, RM). Lincoln Co., Waldo, *Howell s.n.*, June 1887 (MIN). Linn Co., Santiam slough near Lebanon, *Gilkey & Drake s.n.*, June 1934 (OSC). Marion Co., Jefferson, *Nelson 177* (DS). Multnomah Co., Lower Albina, Portland, *Sheldon S. 10328* (F, GH, MIN, MO, NY, US, WS). Polk Co., Nesbit, *Nelson 2073* (GH). Tillamook Co., Sand Lake south of Tillamook, *Thompson 722* (WTU). Wasco Co., Eight Mile Creek, Mt. Hood National Forest, *Jones 4071* (CAS). Washington Co., Forest Grove, *Lloyd s.n.*, 20 April 1893 (GH, NY). Yamhill Co., specific locality unknown, *Summers s.n.*, June 1880 (MONTU). WASHINGTON: King Co., Seattle, *Piper s.n.*, 29 May 1889 (WTU). Klickitat Co., Bingen, *Suksdorf 5014* (WS). Pierce Co., prairies, Tacoma, *Flett s.n.*, 2 October 1897 (WTU). San Juan Co., Cattle Point, San Juan Islands, *Peck 12944* (WS).

As in *Sagina decumbens* ssp. *decumbens*, there is considerable variation in the glandular pubescence character. Although in the original description Watson indicates the taxon as being glabrous, both glabrous plants and plants with sparsely pubescent flowers are present on the type sheet. Few of the flowers of the pubescent form in this collection are glandular. However, the glandular form is predominant in the taxon and relatively few herbarium sheets consist entirely of glabrous specimens.

In the northern portion of its range more robust plants appear very similar to more slender growth forms of *Sagina maxima* ssp. *crassicaulis*. This observation led Piper (1906) to state that species lines in *Sagina* were not well defined and he doubted that the two taxa were really distinct. The saginoid seed type readily distinguishes this taxon from *S. maxima* ssp. *crassicaulis*.

Although not previously recognized nomenclaturally, *Sagina decumbens* ssp. *occidentalis* has long been considered to be the western equivalent of *S. decumbens*. Watson (1875, p. 344) makes a note to this effect in the original description of the taxon and distinguishes it from the eastern taxon by its "laxer and slenderer habit, more elongate pedicels, and in the somewhat less conical base of the calyx." This description falls within the range of variability of both taxa.

Although there is considerable overlap in characteristics, *Sagina decumbens* ssp. *decumbens* can generally be segregated on the reticulate ridge pattern of the seed, a greater tendency to possess purple sepal tips or sepal margins, and anthocyanins frequently

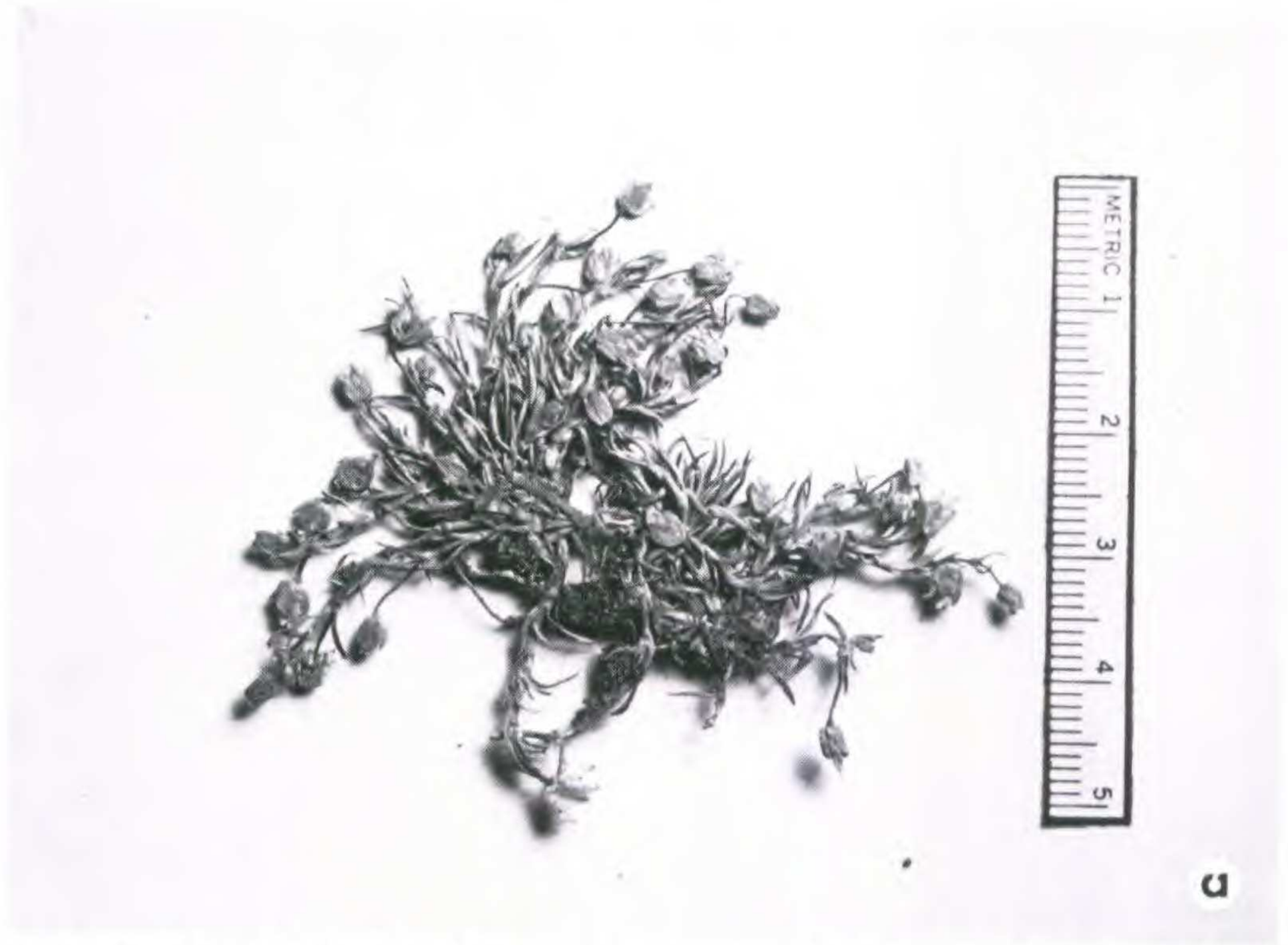

Figure 25. *Sagina maxima* ssp. *maxima*. a. habit; b. close-up showing glandular pubescence. Both Aleutian Islands (*York 44 196*, F).

abundant at the nodes. In ssp. *occidentalis* the sepals tend to be more orbicular and the capsules, prior to dehiscence, are more globose. The seeds lack a reticulate ridge pattern and are never tuberculate.

8. **Sagina apetala** Ard., Animadv. Bot. Spec. alt. **2:** 22. 1764.

Alsinella apetala (Ard.) Krause, in Sturms, Fl. Deutschl. 2 ed., **5:** 38. 1901. TYPE: LINN *177.2.* (Lectotype, LINN!)

Sagina apetala var. *barbata* Fenzl, in Ledeb, Fl. Ross. **1:** 338. 1842. TYPE: Herb. Ledebour 148.1. (Lectotype, LE!)

Sagina filicaulis Jordan, Obs. Pl. Crit. **7:** 16. 1849. TYPE: not seen. ORIGINAL MATERIAL: in sandy places in fields, in the valley of Aspe at Bedous, France, July, 1838. Collected by Jordan.

Sagina quarternella Schloss, in Schloss & Vukot., Fl. Croat. p. 343. 1869. TYPE: Destroyed during World War II. ORIGINAL MATERIAL: in fields and meadows, common in Croatia.

Sagina melitensis Gulia ex Duthie, Jour. Bot. **13:** 37. 1875. TYPE: Dulthie, Insula Melita, Corradino, March 13, 1874. (Lectotype, K!)

Alsinella ciliata Greene, Fl. Franc. p. 126. 1891. *Sagina ciliata* (Greene) Heller, Muhl. **1:** 50. 1904. TYPE: unknown. ORIGINAL MATERIAL: vicinity of Ione, California. Presumably collected by Greene.

Annual with slender taproot. Plants ascending to decumbent, much branched and many flowered. Basal rosette-like whorl of leaves sometimes present, withering early. Stems filiform, glabrous or sometimes glandular pubescent. Lower cauline leaves linear, 4–8 (–12) mm long, upper cauline leaves linear to subulate, 1–3 mm long at apex. Hyaline portion of leaf bases long ciliate; cilia occasionally occurring the length of the leaf, lower cauline leaves sometimes lacking cilia. Leaf tips aristate. Pedicels glandular pubescent (North American plants), short (1.5–) 2.0–5.0 (–13) mm long. Flowers 4-merous, very rarely 4- and 5-merous. Calyx glandular pubescent. Sepals ovoid to elliptical, sometimes lanceolate and somewhat acute, 1.5–2.0 mm long. Petals nearly always lacking, if present then minute. Stamens 4, filaments 0.75–1.0 mm long, anthers 0.2 mm long. Capsules globose, dehiscing to base, valves thin, barely exceeding sepals, 1.5–2.0 (–2.5) mm long. Seeds brown, obliquely triangular, with dorsal groove, distinctly notched at hilum, surface smooth, pebbled or more frequently papillose (papillae distinctly mammillate when viewed under SEM), 0.3–0.4 mm long. Chromosome number: $2n = 12$. Figures 22 and 23.

ECOLOGY AND DISTRIBUTION: Introduced. A weed of open places, frequently in hard packed soils around buildings, along

paths, on roadsides, in sidewalk cracks. It occurs less frequently in such places as grassy hillsides and stream banks. California, western Oregon and Seattle, Washington. I have seen four herbarium specimens from eastern North America referable to this taxon, one from Maryland (1933), one from New Jersey (1878), one from Illinois (no date), and one from Louisiana (1883). The species does not appear to have become established in these regions. Native to Europe. Flowering April to June. Figure 24.

REPRESENTATIVE SPECIMENS: **United States.** CALIFORNIA: Alameda Co., Strawberry Canyon, Berkeley Hills, *Howell 11359* (CAS). Amador Co., Jackson, *Hansen 537* (UC). Calaveras Co., Angels Camp, *Eastwood 11580* (CAS). Eldorado Co., Diamond Springs, *Jepson 18632* (UC). Fresno Co., Parlier, *Frazier 101* (DS, WTU). Humboldt Co., ¼ mi. southeast of village of Willow Creek, *Crow 1927* (MSC, NHA). Lake Co., just north of Middletown, *Howell 42249* (CAS). Los Angeles Co., Pasadena, *Grant s.n.*, 15 April 1917 (DS, JEPS, UC). Madera Co., North Fork, *Bacigalupi 2261* (DS). Marin Co., Black Canyon, San Rafael hills, *Howell 17896* (NY). Mariposa Co., Oakvale, *Congdon s.n.*, 27 April 1897 (GH, MIN). Mendocino Co., near Yorkville, *Eastwood & Howell 4570* (CAS). Merced Co., 15 mi. southwest of Merced, *Howell 4112* (CAS). Monterey Co., Jolon, *Howell 39155* (CAS). Plumas Co., Big Meadows *Manstin s.n.*, August 1899 (US). Sacramento Co., Sacramento, *Crampton 7840* (CAS). San Benito Co., 5 mi. north of Pinnacles, *Howell 33016* (CAS). San Francisco Co., McLarsen Park, San Francisco, *Raven 9254* (CAS). San Joaquin Co., Woodland, *Biswell 181* (UC). San Luis Obispo Co., Santa Lucia Mts., ½ mi. west of Paso Robles, *Hardham 4036* (CAS). San Mateo Co., Jasper Ridge Biological Experimental Area, ca. 5 mi. southwest of Palo Alto, *Thomas 9073* (DS). Santa Barbara Co., vicinity of Pelican Bay, Santa Cruz Island, *Abrams & Wiggins s.n.*, 26 April 1930 (DS); Oak Park, Santa Barbara, *Pollard s.n.*, 11 April 1958 (DAO). Santa Clara Co., San Antonio Valley, Mt. Hamilton Range, *Sharsmith & Sharsmith 3272* (UC). Santa Cruz Co., Boulder Creek, *Hesse 397* (CAS). Shasta Co., Anderson, *Smith s.n.*, 21 April 1913 (CAS). Siskiyou Co., Klamath River at Cherry Flat, Siskiyou Mts., *Wheeler 2606* (GH, MO, US). Stanislaus Co., 8 mi. east of Oakdale, "Haystack Hill," *Hoover 3955* (UC, US). Tehama Co., 5 mi. west of Paskenta, *Baker 12542* (UC). Tulare Co., 4 mi. east of Exeter, *Mason 11718* (UC). Tuolumne Co., Columbia, *Jepson 6297* (JEPS); base of Peoria Mt., *Williamson 102* (CAS, DS). ILLINOIS: Union Co., *Forbes s.n.*, no date (MICH). LOUISIANA: no specific locality, *Langlois s.n.*, April 1883 (CAS). MARYLAND: Calvert Co., Plum Point, *Blake 11658* (CAS, NA). NEW JERSEY: Camden Co., Camden, *Martindale s.n.*, June 1878 (NA). OREGON: Jackson Co., Wimer, *Hammond 46* (MO); 2 mi. north of Central Point, *Peck 14966* (DS, WTU). Josephine Co., Grants Pass, *Piper 5072* (WS). Marion Co., Salem, *Peck 9284* (WTU). Multnomah Co., Albina, Portland, *Suksdorf 1345* (GH, WS). WASHINGTON: Fairhaven, *Piper s.n.*, 2 July 1897 (WS).

Our phase of the species has been regarded as *Sagina apetala* var. *barbata* Fenzl, the glandular pubescent phase. However, the species in Europe is extremely variable with regard to cilia of leaves

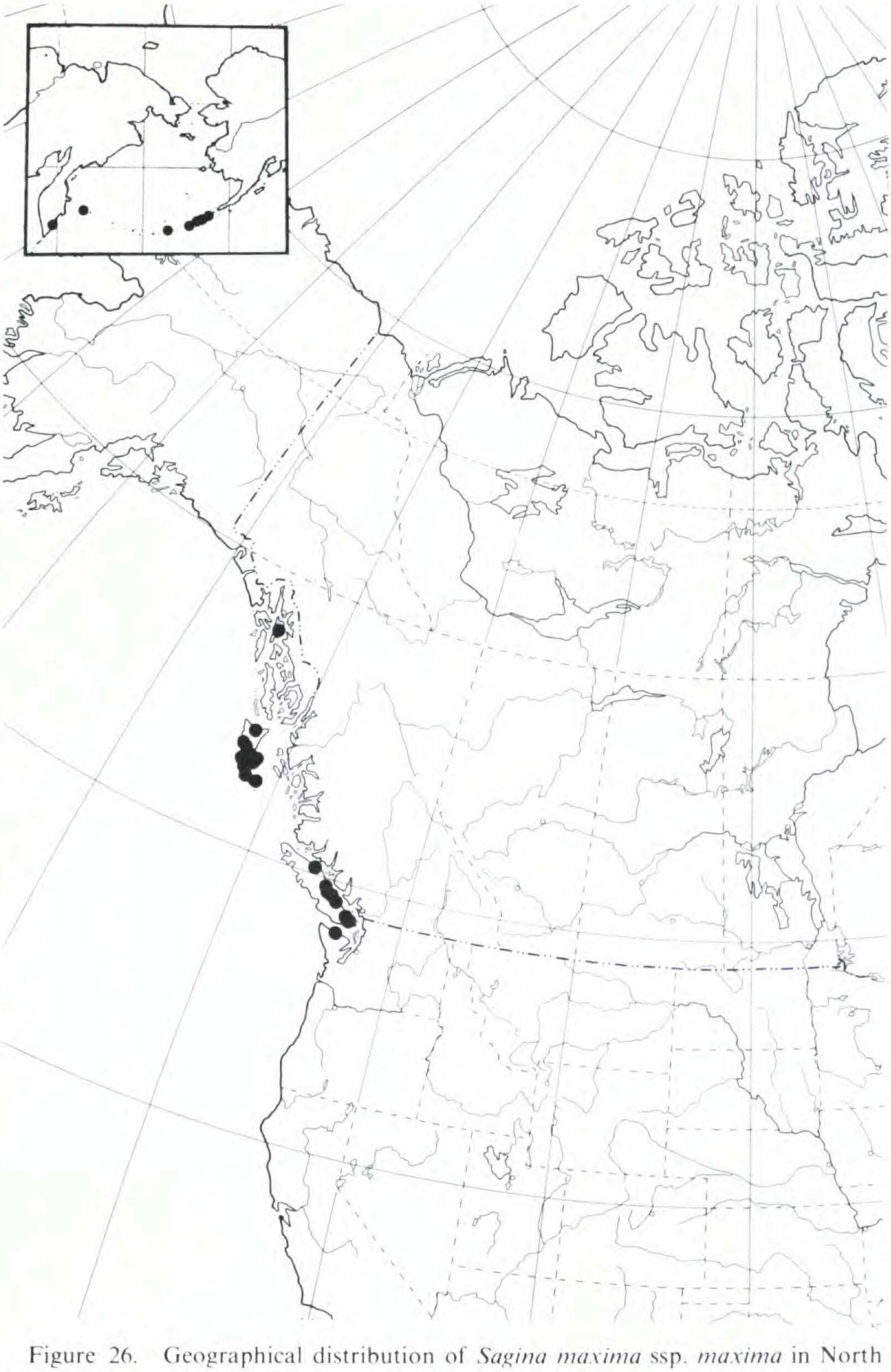

Figure 26. Geographical distribution of *Sagina maxima* ssp. *maxima* in North America.

and pubescence of calyx and pedicels. The character states seem to be without geographical correlation. It thus appears that taxonomic recognition of varieties based on these characters is not valid in this species. The treatment of the species in *Flora Europaea* (Clapham & Jardin, 1964) recognizes two subspecies, ssp. *apetala* and ssp. *erecta*. Our plants do not fit well into either taxon, but do approach ssp. *erecta*. However, the treatment in *Flora Europaea* is regarded by the contributors as tentative. Considering the great variability within the species and that those subspecies recognized in *Flora Europea* are completely sympatric, it does not appear useful to recognize any infraspecific taxa of *S. apetala*.

Linnaeus is often erroneously cited as the author of the name *Sagina apetala*. Following the description of *S. apetala* in *Mantissa Plantarum Altera* Linnaeus (1771) clearly credits Arduino with authorship of the name. The matter is further clarified by reviewing the correspondence between Arduino and Linnaeus preserved in *Linnaeus Correspondence* Vol. I at the Linnean Society of London. Letter no. 164 written by Pietro Arduino in 1763 lists *Sagina apetala* (his no. 59) among specimens he sent to Linnaeus. Linnaeus recorded these plants received and lists this specimen as "Sagina species nova?" Listed in his letter of reply, Linnaeus included "Sagina si careat petalis, ego eam non vidii." The sequence of Linnaeus' list differed from that of Arduino, numbering the only *Sagina* under consideration as no. 39. A pencilled note by Savage in the margin indicates reference to specimen LINN *177.2*. Arduino published *Sagina apetala* as a new species the following year (1764). In the absence of another Arduino specimen of *S. apetala* I have chosen LINN *177.2*. to serve as the lectotype for Arduino's name.

Specimens representing Fenzl's taxa of *Sagina* deposited in Wien (W) were destroyed during World War II (Riedl, personal communication, 1974). Thus I have chosen the *Flora Rossica* specimen at the Komarov Botanical Institute in Leningrad (LE) representing Fenzl's *Sagina apetala* var. *barbata*, HERB. LEDEBOUR *148.1*, to serve as the lectotype.

Sagina sect. **Maxima** Crow, sect. nov.

Semina reniformia vel paene globosa, sine sulco dorsali; folia linearia, succulenta.

Seeds reniform or nearly globose, dorsal groove lacking; leaves

linear, fleshy. Eastern Asia, northward, spanning the Aleutian Islands, south on the Pacific coast in North America to California; New Guinea. TYPE SPECIES: *Sagina maxima* A. Gray.

9a. **Sagina maxima** A. Gray, Mem. Am. Acad. N. S. **6:** 382. 1859.

ssp. **maxima**

Sagina Linnaei Presl var. *maxima* (Gray) Maximowicz, Bull Acad. St. Pétersb. **18:** 372. 1873. TYPE: *C. Wright s.n.*, Cape Sangar, Hakadadi, Japan. U.S. North Pacific Exploring Expedition under Commanders Ringgold and Rodgers, 1853–1856. (Holotype, GH!; isotype, NY!).

Sagina maxima f. *littorea* Mak., Bot. Mag. Tokyo **25:** 156. 1911. *Sagina crassicaulis* var. *littorea* (Mak.) Hara, Jour. Jap. Bot. **13:** 556. 1937. *Sagina maxima* var. *littorea* (Mak.) Hara, Jour. Jap. Bot. **33:** 147. 1958. TYPE: Not seen. *G. Koidzumi s.n.*, Misaki, Prov. Sagami, Japan. December 27, 1905. (Holotype, TI.)

Sagina litoralis Hult., Svensk Vet. Akad. Handl. ser. III. Bd. 5. **2:** 78. 1928. *Sagina crassicaulis* var. *litoralis* (Hult.) Hult., Arkiv. for Botanik **7:** 147. 1968. TYPE: *Hultén 789*, Sarannaja Bay HN, Toporkof Island, South Kamchatka (Holotype, S!).

Annual or short lived perennial, from slender taproot. Stems stout, rarely filiform, much branched, spreading to decumbent. Upper portion of upper stems frequently pubescent. Usually with basal tuft of ascending linear leaves, secondary fascicles or basal rosette rarely present. Cauline leaves linear, succulent, glabrous, upper pairs rarely minutely glandular ciliate. Lower cauline leaves (6–) 8–15 (–20) mm long, upper cauline leaves linear, becoming shorter toward apex but rarely subulate, (2.5–) 3.5–7 (–9) mm long at apex. Leaf tips apiculate. Connate leaf bases conspicuous, forming a shallow scarious cup. Pedicels usually stout or sometimes slender, densely glandular pubescent at base of calyx, becoming less dense toward the lower portion, lower one-fourth usually glabrous. Flowers 5-merous, protandrous. Calyx glandular pubescent at base. Sepals ovate to orbicular (2–) 2.5–3.5 mm long, sepals with hyaline margins whitish, occasionally purple tinged on margins or tips. Petals elliptical to nearly orbicular, 2.0–2.5 (–3.0) mm long. Stamens 10, filaments 1.5–2.0 mm long, anthers 0.25 mm long. Capsules globose prior to dehiscence. Capsule valves thickish, dehiscing to ca. one-fourth the length of the sutures, (3.0–) 3.5–4.5 mm long. Sepals remaining appressed following capsule dehiscence. Seeds reddish-brown, reniform, dorsal groove lacking, lateral sides plump, surface pebbled or less frequently smooth, 0.5 mm long. Chromosome number $2n = 22$, 42 or 44. Figure 25.

ECOLOGY AND DISTRIBUTION: Coastal, growing on rocky or sandy bluffs, along rocky shores and gravelly beaches. The taxon occurs in eastern Asia, spanning the Aleutian Islands and ranging southward along the coast of North America to northern Washington and intergrading with *Sagina maxima* ssp. *crassicaulis* on the Queen Charlotte Islands and Vancouver Island. Subspecies *maxima* in eastern North America is adventive. The taxon occurs sporadically and does not show signs of aggression or spreading. Known localities include Toronto, Montreal and Quebec, Canada and Amherst, Massachusetts. Flowering June to August. Figure 26.

REPRESENTATIVE SPECIMENS: **Canada.** BRITISH COLUMBIA: Queen Charlotte Islands, Empire Anchorage, Athlow Bay, Graham Island, *Calder, Savile & Taylor 21443* (DAO); Old Masset, Graham Island, *Calder, Savile & Taylor 21241* (DAO); Hotspring Island, *Calder, Savile & Taylor 22280* (DAO, DS); Limestone Island, *Calder, Savile & Taylor 22424* (DAO); Cumshewa Inlet, Moresby Island, *Calder, Savile & Taylor 21969* (DAO); Fairfax Inlet, Tasu Sound, Moresby Island, *Calder & Taylor 23620A* (DAO); Skedans group off Louise Island, *Calder, Savile & Taylor 22388* (DAO, WS), Vancouver Island, Esquimalt, *Calder & MacKay 29529* (DAO); Seabird Rocks between Cape Beal and Pachena Pt., 48°45'N., 125°10'W., *Calder & MacKay 30253* (NY, OSC); near Port Alberni, *Henry 9059* (GH); Campbell River, *Howell 7712* (CAS); Nanimo, *Macoun 24032* (NY); Oak Bay, vicinity of Victoria, *Macoun 78513* (CAN, F, MO); District of Renfrew, *Rosendahl & Brand 62* (COLO, NY, US). ONTARIO: Toronto, *Clarkston s.n.*, 4 August 1946 (WAT). QUEBEC: Montebello, *Charlebois 5* (DAO).

United States. ALASKA: Mouth of Mahoney Creek, George Inlet, Revillagigedo Island, *Shacklette 4853* (US). ALEUTIAN ISLANDS: Ilak Island (near Adak Island), *Bank 361-A* (MICH, US); Carlisle Island, *Bank 511* (MICH); Adak Island, *Jordal 2623* (CAN, US); Iliulink Unalaska, *Jepson 232* (UC, US); Umnak Island, *Johnson 1052* (WIS); Akutan Island, *Rudd s.n.*, July 1935 (WTU); Attu Island, *Van Shaack 776* (GH, US); Aleutian Island, specific locality unknown, *York 196* (F, MO). MASSACHUSETTS: Hampshire Co., Amherst, *Torrey s.n.*, 25 June 1951 (WTU). WASHINGTON: Clallam Co., Port Crescent, *Lawrence 259* (UC, WS).

In contrast to the east Asian members of this taxon, specimens from the Aleutian Islands and the west coast of North America tend to have slightly larger flowers and smooth seeds. In addition, pubescence is less dense and seldom occurs on the stems. Presence of pubescence was the basis for Hultén's recognition of *Sagina litoralis* Hult. However, characteristics demarking his taxon lie within the range of variability of the east Asian populations.

9b. **Sagina maxima** ssp. **crassicaulis** (Wats.) Crow, comb. nov. BASIONYM: *Sagina crassicaulis* Wats., Proc. Am. Acad. **18:** 191. 1883.

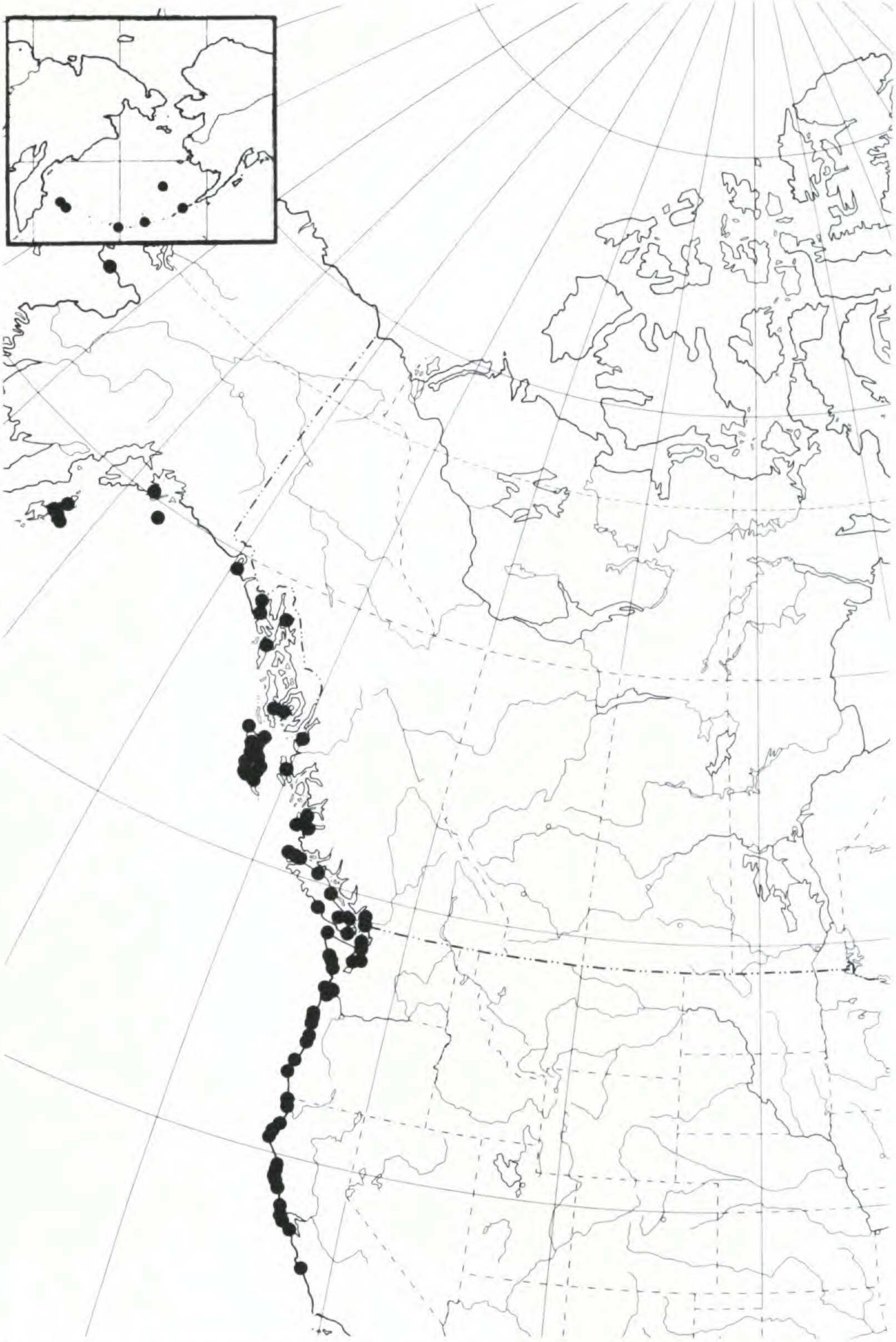

Figure 27. Geographical distribution of *Sagina maxima* ssp. *crassicaulis*.

Alsinella crassicaulis (Wats.) Greene, Fl. Franc. p. 125. 1891. *Sagina maxima* var. *crassicaulis* (Wats.) Hara, Rhodora **41:** 392. 1939. *Sagina maxima* f. *crassicaulis* (Wats.) Mizushima, Jour. Jap. Bot. **35:** 337. 1960. TYPE: *Congdon s.n.*, Dillon's Beach, Marin Co., California, June 6, 1880 (Holotype, GH!; isotype, MIN!).

Perennial. Plants glabrous. Stem stout or rarely filiform, much branched, spreading, decumbent or procumbent. Basal rosette of broadly linear succulent leaves, or if lacking, then primary or secondary tufts of ascending linear basal leaves present; ascending leaves with conspicuous midrib, usually less succulent than rosette leaves (rosettes rarely present in plants occurring north of Washington). Nodes frequently purple tinged. Cauline leaves linear, succulent. Lower cauline leaves 6–15 mm long, upper cauline leaves linear, becoming shorter toward apex but rarely subulate, 3.0–7.0 mm long at apex. Leaf tips apiculate. Connate leaf bases conspicuous, forming shallow scarious cup. Pedicels slender to stout. Flowers 5-merous, protandrous. Sepals ovate to nearly orbicular (2.0–) 2.5–3.0 (–3.5) mm long, hyaline margins whitish, occasionally purple tinged along margins or at sepal tips. Petals conspicuous, elliptical to orbicular (1.5–) 2.0–2.5 (–3.0) mm long, slightly shorter than sepals. Stamens 10, filaments 1.5–2.0 mm long, anthers 0.3–0.5 mm long. Capsules globose prior to dehiscence. Valves thickish, dehiscing to ca. one-fourth the length of the sutures, (3.0–) 3.5–4.0 (–4.5) mm long. Sepals remaining appressed following capsule dehiscence. Seeds reddish-brown, reniform, lateral sides plump, dorsal groove lacking surface smooth to slightly pebbled dorsally, 0.5 mm long. Chromosome number: $2n = 46, 66$.

ECOLOGY AND DISTRIBUTION: Strictly coastal, predominantly on sandy bluffs or crevices of rock cliffs of the Pacific Coast, most frequently at or near the high tide mark. Less often on gravelly-sandy beaches. Monterey Co., California, northward to the Aleutian Islands. Flowering May to September. A few specimens have been collected in flowering condition from California in December and February. Figure 27.

REPRESENTATIVE SPECIMENS: **Canada.** BRITISH COLUMBIA: Fulford Harbour, Saltspring Island (Straight of Georgia), *Ashlee s.n.*, 24 July 1960 (DAO). Duncan Bay, ca. 6 mi. west northwest of Prince Rupert, *Calder, Savile & Ferguson 14956* (DS, WTU). Hope Island, off north end of Vancouver Island, *Calder & MacKay 31180* (DAO). Vancouver, *Greene s.n.*, 19 July 1890 (US). Ann Island, Queen Charlotte Sound, *McCabe 1783* (UC). Calvert Island, head of Kwakshua Inlet, *McCabe 1701*

(UC). Crane Rocks, Gordon Channel, *McCabe 7103* (UC). Hakai Pass, *McCabe 7203* (DS, UC, WTU). Nigei Island, *McCabe 7075* (UC). Porcher Island, Freeman Pass, *McCabe 7345* (UC, WTU). Spider Island, *McCabe 4337* (UC). Queen Charlotte Islands, east side of Naden Harbour, Graham Island, *Calder & Taylor 36872* (DAO); Massett Inlet, Graham Island, *Calder, Savile & Taylor 21642* (DAO); Deena River, Skidegate Inlet, Moresby Island, *Calder & Taylor 23785* (DAO); Louise Island, *Osgood s.n.*, 29 June 1900 (US). Vancouver Island, Fanny Bay, south of Courtnay, *Calder & MacKay 30619* (DAO); Hesquiat Harbour, ca. 49°29′N., 126°24′W., *Calder & MacKay 31107* (DAO); Ivy Green Provincial Park, 2½ mi. northwest of Ladysmith, *Calder & MacKay 28979* (DAO); Kelsey Bay, 50°22′N., 125°57′W., *Calder & MacKay 32454* (DAO); Sarita, 48°53′N., 125°02′W., *Calder & MacKay 30342* (DAO); Port Alberni, *Henry 9060* (GH); vicinity of Ucleulet, *Macoun 78507* (CAN, F); Nanaimo, *Macoun 24032* (CAN); Bould Point, 4 mi. west of Jordan River, *McCabe 5586* (UC).

United States. ALASKA: Beardslee Island, Glacier Bay, *Anderson 1218* (NY). Farragut Bay, *Coville & Kearney 477* (US). Sitka, *Cowles 1085* (US). Port Vita, Raspberry Strait, Raspberry Island, Kodiak group, *Everdam 4026* (CAN, GH, MIN, UC, WTU). Washington Bay, Kuiu Island, *Everdam 5462* (WTU). Helm Bay, Cleveland Peninsula, *Flett 1981* (US). Attu Island, ½ mi. northeast of Krupa Point, Aleutian Islands, *Hardy 241* (GH). Nome, *Hill 137* (US, WS). Agattu Island, Aleutian Islands, *Hultén 6296* (CAS, DS). Amchitka Island, Aleutian Islands, *Hultén 6467* (US). Atka Island, Aleutian Islands, *Hultén 6968* (CAS). Kenai Peninsula, Seward, *Hultén 7966* (US). Afognak Island, Shelikof Strait off Alaskan Peninsula, *Rich s.n.*, August 1931 (DS). Popof Island, Shumagin Islands, *Saunders 3706* (MO). Revillagigedo Island, George Inlet, *Shacklette 4853* (MICH). Unalga Island, Unalaska, *Steenis 4657* (WIS). Middleton Island, Gulf of Alaska, *Thomas 6394* (CAN, DS, US). Long Island, Kodiak, *Trelease 3695* (US). Yakutat Mission, Yakutat Bay, *Trelease 3701* (MO, US). Prince of Wales Island, *Walker & Walker 913* (GH). Gravina Island, *Went 127* (US). CALIFORNIA: Del Norte Co., Crescent City, *Ripley & Barneby 6759* (CAS, NY). Humboldt Co., Big Lagoon, *Tracy 17927* (DAO, US, WS, WTU). Marin Co., Dillon's Beach, *Crow 1183* (MSC, NHA). Mendocino Co., 2 mi. south of Westport, *Crow 1197* (MSC, NHA). Monterey Co., Asilomar, Monterey Peninsula, *Howell 40368* (CAS). San Francisco Co., Baker's Beach, *Raven 2741* (CAS). Santa Cruz Co., Santa Cruz, *Hesse 986* (DS). OREGON: Clatsop Co., Columbia River, Astoria, *Nelson 3126* (GH). Coos Co., Coos Head, *Abrams & Benson 10589* (DS). Curry Co., Port Orford, *Peck 8435* (CAS, GH, MO, NY). Douglas Co., Winchester Bay, *Pringle s.n.*, 22 October 1881 (CAS, MSC). Lane Co., Heceta Head, *Cronquist 6112* (WS). Lincoln Co., Seal Rocks, *Peck 10595* (WTU). Tillamook Co., Tillamook, *Howell s.n.*, 15 July 1882 (F, MIN, MO, NY, US). WASHINGTON: Clallam Co., Clallam Bay, *Jones 5981* (WTU). Grays Harbor Co., Ocean City, *Jones 3894* (WTU). Island Co., Cornet Bay, Whidbey Island, *Smith 1520* (UC, WTU). Jefferson Co., Ruby Beach, 10 mi. north of Queets, *Meyer 1002* (MO, US). King Co., Seattle, *Piper 470* (US, WS). Kitsap Co., Orchard Point, *Piper 2312* (F, GH, WS). Pacific Co., Ilwaco, *Piper 4996* (US, WS). San Juan Co., Cattle Point, *Peck 12688* (WS). Wahkiakum Co., Altoona, *Suksdorf 6682* (WS).

In the original publication of this taxon, Watson (1883) cites the type specimen as "on Dillon's Beach, Marin County, California (J. W. Congdon, June 1880)." The holotype (GH) is dated June 6,

1880 and is a poorly developed plant. An isotype, acquired by the University of Minnesota (MIN) by the purchase of the herbarium of J. W. Congdon, is much more robust and is more representative of the plants at the type locality and of the taxon as a whole.

Climatic conditions in the higher latitudes sometimes have a dwarfing effect on the growth habit, and several specimens of *Sagina maxima* ssp. *crassicaulis* from Kodiak Island and the Aleutians are somewhat caespitose. These specimens tend to approach *S. nivalis* in general appearance.

Where the ranges of *Sagina maxima* ssp. *maxima* and ssp. *crassicaulis* overlap there is considerable intergradation between the two taxa. Variation of pubescence in populations on Vancouver Island and the Queen Charlotte Islands ranges from completely glabrous specimens to individuals with pedicels and calyx bases weakly pubescent to specimens with densely pubescent pedicels. Several specimens exhibiting a filiform habit and weak glandular pubescence are suggestive of *S. decumbens* ssp. *occidentalis*. However, they may be readily distinguished from the latter by the crassuloid seed.

10. **Sagina japonica** (Sw.) Ohwi, Jour. Jap. Bot. **13:** 438. 1937.

Spergula japonica Sw., Gesellsch. Nat. Freunde Berlin, Neue Schrift **3:** 164. 1801. TYPE: not seen. ORIGINAL MATERIAL: in low, moist regions, Japan.

Sagina japonica f. *glaberrima* Mizushima, Jour. Jap. Bot. **35:** 258. 1960. TYPE: *H. T. Tsai 52295*, in woodlands, 1800 m alt Cheng-hsiung Hsien, Yunnan, China. June 21, 1932. (Holotype, GH!)

Sagina sinensis Hance, Jour. Bot. **6:** 46. 1868. TYPE: *Sampson*, Exsicc. No. 13060. Isl. Kulagsu, across from Amoy, China. May 1866. (Holotype, K!).

Sagina Taquetii Léveillé, Fedde Rep. Sp. Nov. **10:** 350. 1912. TYPE: *Taquet 4125*, littoral zone, southern part of Quelpart, Korea. (Holotype, E!)

Sagina echinosperma Hayata, Icon. Plant. Formos. **2:** 39. 1913. TYPE: *S. Saski s.n.*, 9000 ft. alt., Mt. Morrison, Formosa, 25 October 1909. (Holotype, TAI; isotype, TI!).

Annual, from slender taproot. Stems usually filiform, much branched, ascending to spreading, upper portion of upper stems frequently glandular pubescent. Frequently with basal tuft of ascending linear leaves, secondary fascicle or rosette rarely present. Cauline leaves linear, succulent, glabrous or rarely pubescent. Lower cauline leaves 9–20 mm long, becoming shorter toward the apex, 4.0–7.0 mm long at apex. Leaf tips apiculate. Connate leaf bases conspicuous, forming a shallow scarious cup. Pedicels slen-

Figure 28. *Sagina japonica*. a. habit, Japan (*Ohwi 9142*, UC); b. close-up showing glandular pubescence, Japan (*Ohwi s.n.*, 9 May 1950, MO).

der, densely glandular pubescent at base of calyx, becoming less densely so downward, lower one-fourth of pedicel usually glabrous. Flowers 5-merous. Calyx glandular at base. Sepals elliptical to orbicular, 2.0–2.5 mm long, hyaline margins whitish. Petals ovate to orbicular, 1.0–2.0 mm long, sometimes caducous. Stamens 10 or 5, filaments 1.5 mm long, anthers 0.25–0.3 mm long. Capsules globose prior to dehiscence, the valves thickish, dehiscing to one-fourth the length of the sutures, 2.5–3.0 mm long. Sepals remaining appressed following capsular dehiscence. Seeds dark brown, reniform to nearly globose, dorsal groove lacking, sides plump, the surface densely tuberculate, 0.4–0.5 mm long. Chromosome number: $2n = 42$ or 44. Figure 28.

ECOLOGY AND DISTRIBUTION: Introduced. Growing in dryish sites and waste places. The only North American collections known are from Nanaimo, Vancouver Island and Prince Rupert, British Columbia; Portland, Oregon and Ottawa, Ontario. Native to east Asia. Flowering June to August.

REPRESENTATIVE SPECIMENS: **Canada.** BRITISH COLUMBIA: Prince Rupert, *Groh 469* (DAO). Nanaimo, Vancouver Island, *Macoun s.n.*, 10 June 1887 (CAN). ONTARIO: Ottawa, Dominion Arboretum, *Groh 1696* (DAO).

United States. OREGON: Albina, Portland, *Suksdorf 2772* (WS) and *2863* (WS).

CHROMOSOME NUMBERS

Very little information is presently available on chromosome numbers in *Sagina*. Publications indicate that two basic chromosome numbers, $x = 6$ and $x = 11$ (Darlington & Wylie, 1956) and perhaps a third, $x = 7$ (Löve & Löve, 1975), occur in the genus.

Table 2 summarizes the chromosome numbers known for the taxa of *Sagina* which occur in North America. A large portion of the published counts is based on European material. Dr. J. K. Morton has graciously provided his previously unpublished counts, all based on North American plants. Voucher specimens for Morton's counts are deposited in the herbarium of the University of Waterloo, Ontario, Canada (WAT).

Table 2. **Chromosome Numbers For Taxa of Sagina Occurring in North America**

Taxon	**2*n*** Number	Reference or Voucher Specimen
S. nodosa	56	Blackburn, in Tischler (1938)
	56	Blackburn & Morton (1957)
	56	Gadella & Kliphuis (1968)
	44	Löve & Löve (1956)
	56	**Canada.** QUEBEC: Bic Island, Gulf of St. Lawrence off the Gaspé Peninsula, *Morton NA 3967.*
	56	**Canada.** QUEBEC: St. Fabien, Gaspé Peninsula, *Morton NA3917.*
	56	**Canada.** ONTARIO: Neys Provincial Park, Lake Superior, *Morton NA3711.*
	56	**Canada.** NEWFOUNDLAND: Cape St. George, *Morton s.n.*
	56	**Canada.** NEWFOUNDLAND: Daniel's Harbour, *Morton, s.n.*
	22–24	Wulff (1937)
S. saginoides	22	Blackburn, in Wright (1938)
	22	Blackburn & Morton (1957)
	22	Löve & Löve (1956)
	22	Packer (1968)
	c. 22	**United States.** MONTANA: Glacier National Park, *Crow 1103.*
	22	**United States.** MONTANA: Bear Tooth Mts., *Morton s.n.* (meiotic and mitotic counts)
	22	**United States.** MONTANA: Cooke City, Yellowstone National Park, *Morton s.n.*
	22	**United States.** WASHINGTON: Mt. Rainier, *Morton NA3324.*
	22	**Canada.** ALBERTA: Cameron Lake, *Morton s.n.*
	22	**Canada.** ALBERTA: Mt. Edith Cavell foot, Jasper National Park, *Morton NA4624a.*

Table 2 (Cont.)

Taxon	2*n* Number	Reference or Voucher Specimen
S. saginoides (cont.)	22	**Canada.** ALBERTA: Mt. Edith Cavell foot, Jasper National Park, *Morton NA4623.*
	c. 22	**Canada.** ALBERTA: Wilcox Mt., Columbia Icefield, Jasper National Park, *Morton NA4635.*
	22	**Canada.** ALBERTA: Waterton Lakes National Park, *Morton NA4731.*
	c. 22	**Canada.** ALBERTA: Highwood Pass, Coleman Hwy., *Morton s.n.*
S. procumbens	22	Blackburn, in Tischler (1938)
	22	Blackburn & Morton (1957)
	22	Calder & Taylor (1968)
	22	Gadella & Kliphuis (1966, 1971)
	22	Rohweder (1937, 1939)
	22	Wulff (1937)
	22	**United States.** VERMONT: White River, *Morton s.n.*
	22	**Canada.** NOVA SCOTIA: Cape Breton, Dingwall, *Morton NA4284a.*
	22	**Canada.** NOVA SCOTIA: Cape Breton, Dingwall, *Morton NA4284b.* (meiotic count)
	22	**Canada.** QUEBEC: St. Louis de Blandford, *Morton NA4313.*
	22	**Canada.** BRITISH COLUMBIA: Vancouver, *Morton NA3353.*
S. subulata	22	Blackburn & Morton (1957)
	22	Findlay & McNeill (1973)
	22	Löve & Löve (1956)
	18	Rohweder (1937, 1939)
S. nivalis	84	Blackburn & Morton (1957)
	88	Löve & Löve (1948, 1956)
	c. 88	**Canada.** ALBERTA: Mt. Edith Cavell foot, Jasper National Park, *Morton NA4624b.*

Table 2 (Cont.)

Taxon	2*n* Number	Reference or Voucher Specimen
S. caespitosa	88	Knaben (1950)
	88	Löve & Löve (1956)
	100 (higher than)	Löve & Löve (1944)
S. decumbens ssp. *decumbens*	36	**United States.** NORTH CAROLINA: Hatteras Seashore, *Morton NA2636.* (meiotic count)
S. apetala	12	Blackburn & Morton (1957)
	12	Diers (1961)
S. maxima ssp. *maxima*	42 or 44	Blackburn, in Wright (1940)
	44	Calder & Taylor (1968)
	22	Taylor (1967)
S. maxima ssp. *crassicaulis*	66	Calder & Taylor (1968)
	46	**United States.** CALIFORNIA: Marin Co., *Crow 1181.* (meiotic count)
S. japonica	42 or 44	Blackburn, in Wright (1940)

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DEPARTMENT OF BOTANY AND PLANT PATHOLOGY
UNIVERSITY OF NEW HAMPSHIRE
DURHAM, NEW HAMPSHIRE 03824